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# The dynamics of nongame bird breeding ecology in Iowa alfalfa fields

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The dynamics of nongame bird breeding ecology

in Iowa alfalfa fields



by

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# GENERAL INTRODUCTION

The bird community of alfalfa (*Medicago sativa*) hayfields are similar to those found on prairies (grasslands). In Iowa, less than 0.02% of presettlement prairie remains (Smith 1981). Thus of necessity, grassland birds have had to nest in hayfields and other similar habitats to survive (Dinsmore 1981). Birds nesting in crop fields, especially alfalfa hayfields, must cope with a drastically changed environment. Fields are managed to achieve the best possible forage for livestock. Consequently, the needs of nesting birds are usually ignored.

Alfalfa production will probably continue to be an integral part of forage production, especially for dairy farmers. In addition, forage producers are increasingly planting new alfalfa cultivars which have resulted in earlier mowing of hay fields in the spring. Thus, it becomes important to understand the ecology of nesting birds in modern alfalfa fields so that consideration can be given to the needs of these birds.

My results will increase knowledge of birds nesting in alfalfa fields and will add to the understanding of the relationships between the birds and their environment and of how humans can influence this relationship. In the end, however, I hope that alfalfa producers will gain a new perspective on how their land management decisions affect birds nesting in their fields.

## Explanation of Thesis Format

This thesis is organized according to the guidelines for the alternative thesis format. It is composed of two papers written for publication in scientific journals. Section I reports on the effects of mowing and the subsequent regrowth of vegetation on breeding bird populations in alfalfa fields. Section II discusses the effects of mowing on nesting success. Data acquisition, statistical analyses, and the preparation of the text for both sections were the responsibility of the candidate; however, guidance and editorial advice were supplied by Dr. Louis B. Best.

# SECTION I. EFFECTS OF MOWING ON BREEDING BIRD ABUNDANCE AND SPECIES COMPOSITION IN ALFALFA FIELDS

# ABSTRACT

Eight nongame bird species established territories in alfalfa (*Medicago sativa*) fields before mowing occurred. In order of decreasing abundance on 30 May they were dickcissels (*Spiza americana*), red-winged blackbirds (*Agelaius phoeniceus*), western meadowlarks (*Sturnella neglecta*), common yellowthroats (*Geothlypis trichas*), sedge wrens (*Cistothorus platensis*), grasshopper sparrows (*Ammodramus savannarum*), mourning doves (*Zenaida macroura*), and vesper sparrows (*Pooecetes gramineus*). Mowing reduced the density and the number of nongame species attempting to nest in alfalfa fields. Only dickcissels, grasshopper sparrows, western meadowlarks, and vesper sparrows bred in the second alfalfa crop. The occurrences of common yellowthroats and grasshopper sparrows within alfalfa fields was related to the distribution of suitable vegetation. Common yellowthroats selected the tallest, densest vegetation with a relatively high coverage of grass; grasshopper sparrows used areas of sparse vegetation. In contrast, dickcissels and red-winged blackbirds were distributed throughout the alfalfa fields, although their abundance was directly related to vegetation density throughout the period of alfalfa regrowth. Vesper sparrow and grasshopper sparrow abundance seemed to be directly related to vegetation density (structure) until the alfalfa reached a height of about 30 cm; at greater alfalfa

heights, the abundance of these species seemed inversely related to vegetation density. Western meadowlark abundance seemed unrelated to vegetation changes.

# INTRODUCTION

Alfalfa (Medicago sativa) ranks as one of the most important forage plants in the U.S. because it has the highest nutritional value, especially protein, for livestock of all commonly grown hay crops (Barnes and Gordan 1972). About two-thirds of the estimated 11 million ha of alfalfa grown annually in the U.S. is harvested in the north-central states (Barnes and Sheaffer 1985). About 640,000 and 586,800 ha of alfalfa was harvested in Iowa during 1986 and 1987, respectively (Iowa Crop Rep. Serv. 1987, 1989).

Birds that nest in alfalfa fields encounter events unique to hayfields. Throughout the growing season, alfalfa fields are in a continuous state of regrowth. In the spring, the vegetation in fields changes from short and sparse to tall and dense. Then the first mowing occurs, and the field's vegetation is reduced to 7 to 10-cm-tall stubble (Barnes and Sheaffer 1985), causing growth to begin again. Before the growing season ends, this cycle will usually occur at least 3 times. Thus, mowing drastically changes the amount and structure of vegetation available to birds and probably affects bird population density. Most research investigating the effects of mowing on birds has concentrated on game birds (Labisky 1957, Milonski 1958, Gates 1965, Gates and Hale 1975, Hartman and Fisher 1984, Warner and Etter 1989). Little research, however, has been directed at how nongame birds respond to the abrupt removal of vegetation and the subsequent regrowth (see Harrison 1974).

Several bird species commonly nesting in hayfields have declined recently (Zimmerman 1979, Robbins 1982, Castrale 1985, Zaletel and Dinsmore 1985, Robbins et al. 1986, Applegate and Willms 1987, Adams et al. 1988). According to a comparison of Breeding Bird Survey data for Iowa between 1968-1970 and 1978-1980, eastern (Sturnella magna) and western meadowlark (Sturnella neglecta), and dickcissel (Spiza americana) populations have declined (Zaletel and Dinsmore 1985). A population decline also is suspected for grasshopper sparrows (Ammodramus savannarum) (Robbins et al. 1986, Tate 1986). These four species are among the terrestrial birds having the greatest rate of population decline in the U.S. between 1966 and 1986 (U.S. Fish Wildl. Serv. as cited by Counc. Environ. Quality 1988). Robbins (1982) and Bollinger (1988) implicated mowing effects as a possible reason for the reported population declines.

My study was undertaken (1) to determine the species composition and abundance of nongame birds breeding in alfalfa fields and (2) to evaluate the effects of hay mowing on population density of these birds. My results pertain to the first and second alfalfa crops and the effects of the first mowing.

# STUDY SITE AND METHODS

My study was conducted in Adair County in southwestern Iowa during the spring and summer of 1986 and 1987. Currently, 98% of Adair County is farmland, and 64% is cultivated (Iowa Crop and Livestock Rep. Serv. 1985). Corn and soybeans are the major crops (49% of total acreage of Adair County), with only 7% of the county planted to hay (alfalfa and alfalfa-grass mixtures). The topography of the county is gently rolling, and the climate is subhumid and continental with an average summer temperature of 23 C. The growing season extends from April through September, and the county normally receives nearly 75% of its annual precipitation during this period (Sherwood 1980). South-central Iowa (Des Moines) received above normal precipitation (81 cm, 1958-1987) during both 1986 and 1987 (108 and 94 cm, respectively) (Natl. Oceanic and Atmos. Adm. 1987). Precipitation received during the growing season also was greater than normal (59 cm, 1958-1987) in both 1986 and 1987 (81 and 64 cm, respectively).

Six 7.5-ha alfalfa study plots were selected for study each year, 5 of which were used both years. All alfalfa fields were privately owned, and owners mowed according to their own schedules, independent of my research activities. Study plots were generally square (275 X 275 m) and were situated within alfalfa fields such that they were surrounded by at least a 50-m-wide buffer zone of alfalfa. (One study plot was 225 X 350 m.) Buffer zones were maintained around the plots to exclude species attracted to fencerow habitats rather than the interior of the fields (i.e., to minimize edge effects). Study plots were gridded throughout with survey flags placed at 25-m intervals. The grid markers served as a reference for mapping bird observations and for sampling vegetation. Grid markers were removed from fields shortly before mowing occurred and usually replaced shortly after the bales had been removed from the fields. (In two instances, the grid markers were replaced before the bales had been removed from the fields.)

Breeding bird population densities were estimated before and after the first alfalfa mowing by using the spot-map technique (Robbins 1970). When spot-mapping, an observer walked along alternate grid lines until the study plot had been completely traversed. The 6 plots were censused 172 times ($\bar{x}$ = 29/plot) during 29 April-30 July 1986 and 272 times ($\bar{x}$ = 45/plot) during 17 April-22 July 1987. Censuses were usually conducted between sunrise and 1000 hr but were not performed during unfavorable weather (Robbins 1981). No birds were censused during the period when the grid markers had been removed from the fields to allow mowing. Weekly composite maps were compiled for all plots and used to determine the density of all breeding bird species. In 1986, fewer censuses were completed in the first alfalfa crop; thus, some fields were not visited often enough to determine densities in April and early May. The mowing date recorded for each plot was the day when all or most of the plot was mowed. State crop harvest statistics (Iowa Crop and Livestock Rep. Serv. 1987) were used to calculate statewide average mowing dates for alfalfa (Warner and Etter 1989).

The repeat-flush technique (Wiens 1969) was used to refine population density estimates and to determine territorial boundaries of dickcissels and western meadowlarks. Territories were delimited during a 2 1/2-week period in both the first and second alfalfa crops, mid- to late May in the first crop and 3-5 weeks after the first mowing in the second crop. If major boundary shifts were suspected (e.g., after many new birds established territories in the fields), each male's territory was mapped several times. The proportion of each territory included within the study plot boundaries was estimated as 25, 50, 75, or 100%. All population density estimates determined by the spot-map method and the repeat-flush technique were expressed as the number of territories/100 ha.

Mourning dove (Zenaida macroura) density was determined from early May through mid-July by flushing adults at nests during weekly searches for nests (Rodenhouse and Best 1983). Spot-map and repeat-flush census techniques were ineffective for doves because they defend only a small area around the nest and move considerable distances from the nest to feed (Sayre et al. 1980). Ring-necked pheasants (*Phasianus colchicus*) and brown-headed cowbirds (*Molothrus ater*) also nested in the alfalfa fields, but they could not be censused accurately by my methods because males do not defend territorial boundaries (Gates and Hale 1974, Darley 1982).

The vegetation on each study plot was characterized from measurements taken 1 m north of each grid marker. Vegetation measurements were recorded twice before the first mowing in 1986 (early May and mid-May), 3 times before mowing in 1987 (mid-April, early May and mid-May), and twice at about 2 and 4 weeks after the first mowing in both years. Vegetation density (vertical structure) and average height were measured with a profile density board 15 cm wide by 100 cm tall and graduated at 10-cm intervals (Basore et al. 1986). The percentage of each 10-cm interval obscured by vegetation was estimated from a distance of 2 m and at a height of 1 m. Vertical density was calculated as the sum of the 10 individual interval readings. The percent coverage of bare ground, grasses, forbs, and the dominant plant species was visually estimated within a 1-$m^2$ frame positioned parallel and adjacent to the face of the density board. Territory maps were superimposed over a map of the vegetation sampling points, and those points located within each territory were used to characterize the vegetation of each territory.

Generally, densities of individual bird species, total bird abundance, and vegetation measurements were similar between years, as were mowing dates. Thus, data for the 2 years generally were combined. In 1987, however, bird populations in all fields were censused more completely than in 1986. Therefore, when evaluating temporal patterns, I used only 1987 data.

The number of plots mowed for the first time increased as June progressed. Thus to avoid reporting erratic weekly bird population changes resulting from censusing fewer plots, I used bird population estimates derived for the period before June to represent premowing bird abundance. In the second alfalfa crop, the bird population estimates from my plots were combined on the basis of the number of weeks (1, 2, 3, 4, or 5) since the first mowing.

Throughout the text and in tables, mean values are reported $\pm 1$ standard deviation. Statistical testing consisted of analysis of variance (ANOVA) of unweighted means. Sources of variation used in the analysis of mowing effects (i.e. the difference between bird densities before and after mowing) were year (1986 and 1987), plot (6 plots), date (before and after mowing), and the plot-date, year-plot, and year-date interactions. The error term to test the effect of mowing was the plot-date interaction. Sources of variation used to analyze bird habitat preferences (i.e., the difference between the vegetation of bird territories and the fields in general) were plot and year. The error term to test these differences was the residual after plot and year effects had been removed. Territories with fewer than 2 vegetation sampling points/territory were deleted from analyses. Calculations were made with the Statistical Analysis System (SAS) General Linear Models (GLM) procedure (SAS Institute Inc. 1985). Null hypotheses were rejected at $P \leq 0.05$.

# RESULTS AND DISCUSSION

## Vegetation Changes

The mean (±SD) date for the first alfalfa mowing was 7 June ± 9 days. The statewide mean date (1982-86) for the first mowing was 12 June (Iowa Crop and Livestock Rep. Serv. 1987). The mean interval between the first and second mowings was 39 ± 6 days, compared with a statewide mean interval of 37 days.

From mid-April until shortly before the first alfalfa mowing, bare ground coverage on my study plots decreased from more than 40% to less than 10%. A similar decline occurred during the 4 weeks after the first mowing. Most of the decline in exposed bare ground resulted from an increase in the coverage and height of forbs (Table 1). Forb coverage increased from less than 50% to more than 80% before the first mowing; the rate of increase was rapid early in the growing season but much slower in May (see also Nelson and Smith 1968, Greub and Wedin 1971). Grass coverage, which was initially about 1/5 that of forbs, changed very little over time. In contrast to forb coverage, the height and vertical density of vegetation (primarily alfalfa) increased nearly linearly from mid-April until mid-May. Similarly, Greub and Wedin (1971) and Buxton et al. (1985) reported that the total amount of alfalfa herbage increased nearly linearly during comparable dates. These changes in the coverage and vertical

Table 1. Characteristics (Mean ± SD) of alfalfa fields in Iowa, 1986-87

| | Bare ground (%) | Grass coverage (%) | Forb coverage (%) | Vertical density[a] | Height (cm) |
|---|---|---|---|---|---|
| First Crop | | | | | |
| Mid-April[b] (6)[c] | 41 ± 9.4 | 10 ± 9.2 | 49 ± 12.2 | 59 ± 9.7 | 9 ± 1.8 |
| Early May[b] (12) | 11 ± 10.5 | 9 ± 9.6 | 81 ± 12.2 | 279 ± 55.6 | 33 ± 5.1 |
| Mid-May[b] (12) | 9 ± 5.7 | 10 ± 8.7 | 85 ± 8.7 | 430 ± 40.7 | 50 ± 4.4 |
| Second Crop | | | | | |
| 2 weeks after mowing[d] (11) | 29 ± 15.3 | 10 ± 7.1 | 51 ± 14.9 | 115 ± 51.7 | 18 ± 5.9 |
| 4 weeks after mowing[e] (12) | 9 ± 4.2 | 12 ± 8.2 | 79 ± 8.9 | 399 ± 70.7 | 48 ± 7.0 |

[a]Calculated by summing the individual interval readings from the density board.

[b]Mid-April measured 17-18 April 1987, early May measured 29 April-12 May 1986 and 1-7 May 1987, and mid-May measured 18-20 May 1986 and 15-20 May 1987.

[c]Number of fields sampled. Each field was considered a sampling unit.

[d]Measured 9-13 and 18-20 days after mowing in 1986 and 1987, respectively.

[e]Measured 29-38 and 27-30 days aftermowing in 1986 and 1987, respectively.

structure of forbs, primarily alfalfa, presumably affected the composition and abundance of birds using the alfalfa fields.

## Bird Community Changes

Eight nongame bird species established breeding territories in the alfalfa study fields during 1986-87 (Table 2, Fig. 1). Similarly, 8 territorial nongame breeding bird species were recorded in alfalfa fields in Michigan (Harrison 1974) and in legume-grass meadows in Ohio (Dambach and Good 1940). Characteristically, bird species richness is low in legume, legume-grass, and grass plant communities (Wiens 1973b).

Before mowing occurred (30 May), all 8 species attempted to breed in the alfalfa fields; after the mowing, only 4 species attempted to breed (Fig. 1). Dickcissels, western meadowlarks, grasshopper sparrows, and vesper sparrows (*Pooecetes gramineus*) were present in both the first and second alfalfa crops. Red-winged blackbirds (*Agelaius phoeniceus*), common yellowthroats (*Geothlypis trichas*), sedge wrens (*Cistothorus platensis*), and mourning doves attempted to bred in the first crop. The average number of breeding bird species per alfalfa field the week before mowing ($4.4 \pm 1.0$) was significantly greater than after mowing (2nd week = $2.6 \pm 1.0$ and 4th week = $2.9 \pm 0.9$) ($F = 9.7$ and $F = 8.8$, respectively; 1,5 df; $P = 0.03$). In Michigan, Harrison

Table 2. Mean (±SD) nongame breeding bird densities (males/100 ha) in 1986-87 alfalfa fields[a]

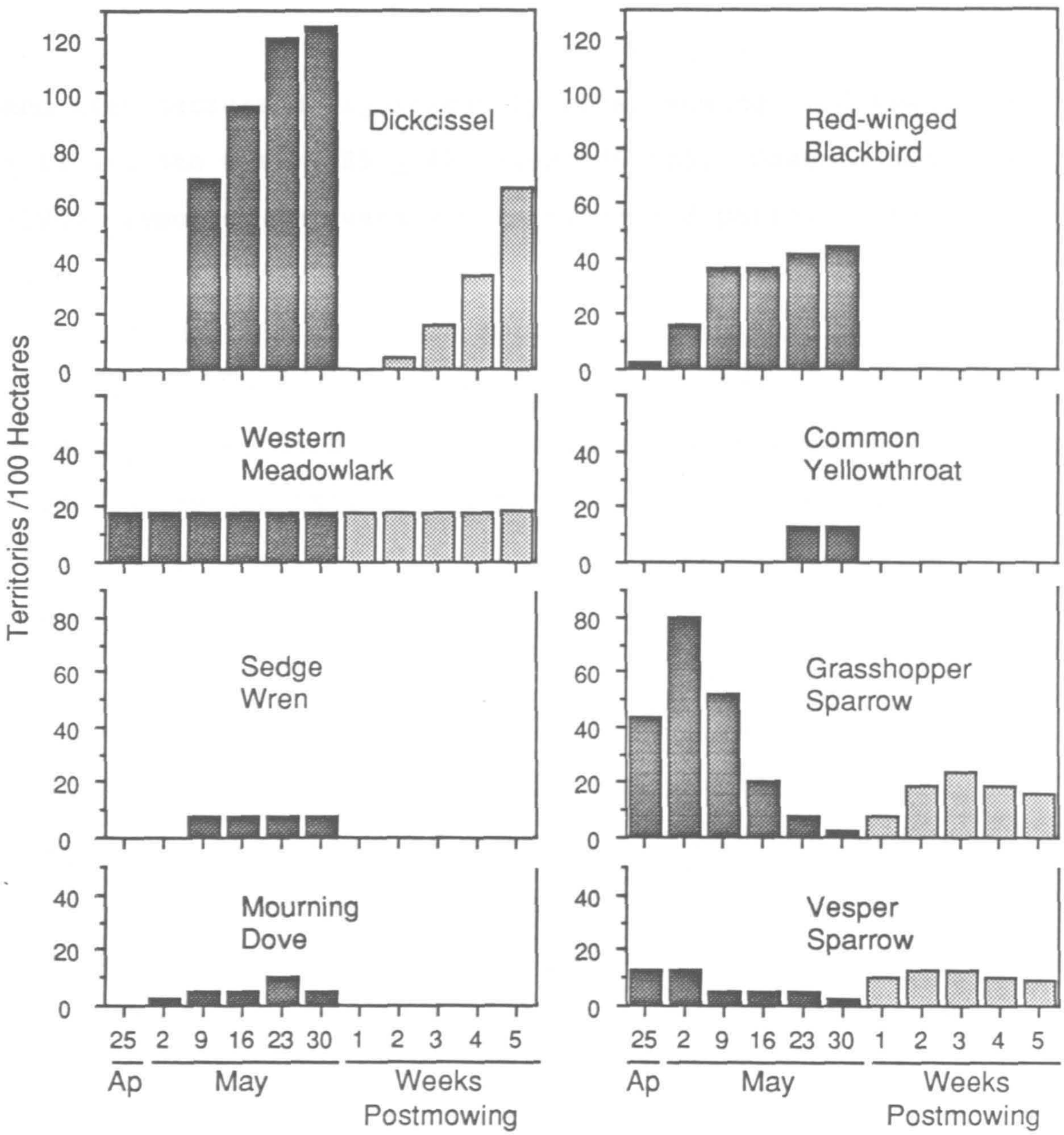
| | Before Mowing[b] | After Mowing[c] | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 weeks | | | 4 weeks | | |
| Species | Density | Density | F | P | Density | F | P |
| Dickcissel | 116 ± 29 | 7 ± 9 | 130.4 | <0.01 | 38 ± 22 | 39.1 | <0.01 |
| Red-winged blackbird | 38 ± 45 | 0 | 7.1 | 0.04 | 0 | 7.1 | 0.04 |
| Western meadowlark | 19 ± 42 | 20 ± 4 | 0.2 | 0.66 | 20 ± 4 | 0.2 | 0.66 |
| Common yellowthroat | 12 ± 12 | 0 | 8.6 | 0.03 | 0 | 8.6 | 0.03 |
| Sedge wren | 8 ± 15 | 0 | 4.8 | 0.08 | 0 | 4.8 | 0.08 |
| Grasshopper sparrow | 6 ± 11 | 16 ± 17 | 2.7 | 0.16 | 21 ± 24 | 1.6 | 0.26 |
| Mourning dove | 3 ± 8 | 0 | 2.2 | 0.19 | 0 | 2.2 | 0.19 |
| Vesper sparrow | 2 ± 5 | 10 ± 13 | 3.1 | 0.14 | 10 ± 12 | 3.4 | 0.12 |

[a]Tests of significance (ANOVA) were conducted between bird densities before and after mowing. n = 11 fields.

[b]Estimates derived from spot-mapping censuses conducted 24-30 May.

[c]Estimates derived from spot-mapping censuses conducted 8-14 and 22-28 days after mowing.

Figure 1. Nongame breeding bird densities in 1987 alfalfa fields. Plotted values represent weekly means before (dark stippling) and after (light stippling) mowing.



Territories /100 Hectares
Dickcissel
Red-winged Blackbird
Western Meadowlark
Common Yellowthroat
Sedge Wren
Grasshopper Sparrow
Mourning Dove
Vesper Sparrow
25 2 9 16 23 30 1 2 3 4 5
Ap
May
Weeks Postmowing

(1974) also documented a decline in the number of bird species breeding in alfalfa fields after mowing.

Total nongame bird abundance in alfalfa fields increased to a maximum before mowing (30 May: 206 $\pm$ 54 males/100 ha) and then decreased significantly after mowing (2nd week: 46 $\pm$ 19 and 4th week: 89 $\pm$ 40 males/100 ha). Dambach and Good (1940) reported an average density of 118 pairs/100 ha in large ($\bar{x}$ = 4.1 ha) meadows of red clover, timothy, alfalfa, and orchard grass during 28 April-19 June. Harrison (1974) reported 364 males/100 ha present in the first alfalfa crop (9 May-10 June) in Michigan. Differences between my total bird density and those of Dambach and Good and Harrison resulted largely from differences in dickcissel and red-winged blackbird abundance.

Temporal patterns in abundance of individual species before mowing varied (Fig. 1). Some species increased in numbers up to the date the alfalfa was mowed (e.g., dickcissels and red-winged blackbirds), some declined in abundance as the mowing date approached (e.g., grasshopper and vesper sparrows), and still others remained relatively unchanged (e.g., western meadowlarks). These differences reflected the way in which the individual species presumably responded to changes in vegetation structure (see Species Accounts).

The dickcissel was the most abundant species in alfalfa fields before mowing (30 May), when they represented 56% of the total bird abundance (Fig. 1). The red-winged blackbird was the only other species constituting more than 10% of the total bird numbers. After mowing, dickcissels again became the most numerous, and by the 4th week after mowing, they composed 42% of the total bird abundance. The next 2 most abundant bird species at that time (second crop) were the grasshopper sparrow (24%) and western meadowlark (22%).

## Species Accounts

### Dickcissel

Spring arrival dates of dickcissels were similar both years; males were first sighted on 3 May 1986 and 5 May 1987. The birds exhibited territorial behavior immediately upon arrival, and occupancy of the alfalfa fields progressed rapidly. Dickcissel numbers peaked just before mowing (Table 2). After mowing, all dickcissels left the alfalfa fields (Fig. 1). Dickcissels began to return the second week after mowing, but their density never reached premowing levels. Two and 4 weeks after mowing, dickcissel density was still only 6% and 33% of levels before mowing, respectively (Table 2).

When males began colonizing my fields 2 weeks after mowing, vegetation height, forb coverage, and/or vertical vegetation density evidently had reached levels of development attractive to dickcissels (Table 1, Fig. 1).

Dickcissels started to colonize alfalfa fields when the vegetation was about 20 cm tall and forb coverage was nearly 60%, assuming linear growth between the two postmowing periods when I measured vegetation (see Greub and Wedin 1971, Buxton et al. 1985). These may represent threshold minima necessary to stimulate a settling response in the species. Dickcissel density increased linearly in the second alfalfa crop, similar to the growth of the vegetation, until it was mowed. This suggests that dickcissels colonizing alfalfa fields after mowing were responding positively to increasing vegetation structure.

Harrison (1974) reported that dickcissels did not return to alfalfa fields in Michigan after mowing, but some possible explanations for this exist. Michigan is on the northern fringe of the species' range (Monroe 1967), and before mowing, dickcissel density in Harrison's study was less than 25% of those I observed. Also, mowing occurred there shortly after male dickcissels returned from their wintering grounds and before females had arrived. Thus, males may not have had sufficient time to develop site attachment.

Vegetation characteristics within dickcissel territories in the first and second alfalfa crops were similar to those of the study plots overall (Tables 1, 3), suggesting no habitat selectivity within fields. Territories were loosely contiguous and nonoverlapping by 30 May, but no study plot was fully used. On the basis of relative abundance of dickcissels within my study plots, alfalfa fields seem to be well suited for this species. Observations by others (Gross 1921, Dambach and Good 1940, Graber and Graber 1963, Emlen and Wiens 1965, Wiens and Emlen 1966) also have indicated that legume and legume-grass hayfields are a preferred habitat of dickcissels. Tall, dense herbaceous vegetation with a substantial forb component has been confirmed as the species' preferred habitat (Zimmerman 1971, Wiens 1973b).

Red-winged Blackbird

In Iowa, male red-winged blackbirds arrive in the spring shortly after snow melts; the peak of migration usually occurs in late March (Dinsmore et al. 1984). Despite their early arrival in the state, males did not establish territories in alfalfa fields in 1987 until late April through mid-May (Fig. 1). (Arrival dates were not recorded in spring 1986.) Holcomb and Twiest (1968), Robertson (1973), Harrison (1974), and Albers (1978) have noted that redwing breeding activity generally begins later in annually mowed upland habitats than in wetlands. Albers (1975) reported that most male redwings returned to Michigan alfalfa fields from mid-April through late May.

Residual cover (i.e., the vegetation from the previous growing season) is an important determinant for territory establishment and nest placement by red-winged blackbirds in

Table 3. Characteristics of bird species territories in the first and second crops[a]

| Crop | Bare ground (%) | Grass coverage (%) |
|---|---|---|
| First crop[c] | | |
| Dickcissel (117)[d] | 7 ± 7.1 | 11 ± 13.4 |
| Red-winged blackbird (21) | 5 ± 5.9 | 7 ± 10.2 |
| Common yellowthroat (9) | 6 ± 3.6 | 28 ± 18.2* |
| Sedge wren (7) | 8 ± 9.6 | 15 ± 18.3 |
| Grasshopper sparrow (50) | 13 ± 10.4 | 8 ± 11.3 |
| Vesper sparrow (11) | 16 ± 9.3 | 12 ± 10.4 |
| Second crop[e] | | |
| Dickcissel (60) | 9 ± 5.0 | 16 ± 14.5 |
| Grasshopper sparrow (21) | 12 ± 5.2 | 24 ± 13.4 |
| Vesper sparrow (10) | 14 ± 6.8 | 11 ± 9.7 |

[a]Tests of significance (ANOVA) were conducted between the vegetation characteristics within the species' territories and those of the fields overall (Table 1).

*Significance level at $P \leq 0.05$.

[b]Calculated by summing the individual interval readings from the density board.

[c]Measured 18-20 May 1986 and 15-20 May 1987.

[d]Sample size. Each territory was considered a sampling unit.

[e]Measured 29-38 and 27-30 days after mowing in 1986 and 1987, respectively.

| Forb coverage (%) | Vertical density[b] | Height (cm) |
|---|---|---|
| 86 ± 14.7 | 443 ± 67.8 | 51 ± 7.9 |
| 90 ± 11.9 | 444 ± 52.4 | 52 ± 4.8 |
| 73 ± 15.9 | 490 ± 55.1 | 58 ± 8.6* |
| 78 ± 23.5 | 409 ± 56.0 | 48 ± 6.0 |
| 82 ± 12.8 | 397 ± 83.1 | 47 ± 9.1 |
| 75 ± 10.5 | 404 ± 87.5 | 49 ± 8.6 |
| 78 ± 15.5 | 399 ± 93.7 | 49 ± 9.6 |
| 69 ± 12.8* | 330 ± 82.2* | 41 ± 7.7* |
| 76 ± 9.6 | 353 ± 112.4 | 44 ± 11.0 |

uplands (Holcomb and Twiest 1968, Harrison 1974, Albers 1978, Buhnerkempe 1979). According to Harrison (1974), territories are initially established on sites in alfalfa fields having the tallest residue vegetation. Robertson (1973) suggested that the vegetation of upland hayfields in early spring failed to provide the structural complexity necessary for nest support and concealment, song perches, and territorial reference points. Similarly, initial territory establishment in my alfalfa fields likely was delayed because of the lack of residual cover resulting from mowing the previous year.

Although the highest density of breeding red-winged blackbirds are found in wetlands (Graber and Graber 1963, Robertson 1973, Besser 1985), most redwings nest in upland habitats because these habitats are more abundant (Graber and Graber 1963). My mean population density estimate for red-winged blackbirds before mowing (Table 2) was similar to the statewide average of 34 adult males/100 ha found in hayfields (Besser 1985). Similar to dickcissel density, red-winged blackbird abundance in the first alfalfa crop increased with increased vegetation density (structure).

Red-winged blackbirds did not colonize alfalfa fields after mowing (Fig. 1; see also Harrison 1974, Albers 1978). The failure of blackbirds to colonize alfalfa fields after mowing probably was related initially to reduced plant cover (structure), but diminishing reproductive drive also likely contributed. Researchers have reported that by late June, few nests are initiated (Beer and Tibbitts 1950, Case and Hewitt 1963, Holcomb and Twiest 1968, Monahan 1977, Krapu 1978), groups of nonbreeding females begin to form (Blakley 1976), males are unlikely to establish new territories (Peek 1971), and adult males stop producing sperm (Wright and Wright 1944). By early July, my fields had developed vegetation structure equal to that available to redwings establishing territories in the first alfalfa crop (Table 1, 3), but by that date, their reproductive cycle was ending.

Vegetation characteristics within red-winged blackbird territories in the first alfalfa crop were similar to those for the study plots in general (Table 1, 3), suggesting little, if any, habitat preference within fields.

Western Meadowlark

Adults normally begin returning to Iowa shortly after snow melts, generally in early or mid-March, with a peak arrival in late March (Dinsmore et al. 1984). Consequently, breeding territories already were well established by the beginning of my study period both years.

Abundance of western meadowlarks in alfalfa fields remained relatively constant throughout the entire study (Fig. 1). Thus, mowing seemingly did not change meadowlark density. In contrast, Harrison (1974) reported that eastern meadowlarks did not return to alfalfa fields after mowing in

Michigan. Harrison's plots were mowed from 12 to 22 June, overlapping the dates when my fields were mowed. Premowing meadowlark density in my fields and those in Michigan were similar, and both meadowlark species have comparable territory sizes (Lanyon 1957, Wiens 1969); however, the position of territories in relation to the study fields differed between my study and that of Harrison (see below).

The large size of western meadowlark territories ($\underline{\bar{x}}$ = 3.4 $\pm$ 1.1 ha, $\underline{n}$ = 13) compared with my study plots made it difficult to accurately assess the effects of mowing or to compare vegetation characteristics within territories with those of the alfalfa fields in general (see also Owens and Myres 1973). Meadowlark territories were rarely confined either to the study plots or to the alfalfa fields in which the plots were located. Rather, most territories included bordering fencerows and extended into adjacent fields. Thus, meadowlark density may have remained stable because only part of most territories was denuded of vegetation by mowing. The lack of eastern meadowlark colonization reported by Harrison (1974) may have occurred, in part, because all his study plots were located within one large (57 ha) field. I would have expected, however, some meadowlarks to remain after mowing because half of his study plot boundaries were positioned similarly to those of my plots, i.e., 50 m from a field edge.

Differences between my observations and those of Harrison probably related to differences between the two meadowlark species. Rotenberry and Wiens (1980) indicated that western meadowlarks will use a wider array of habitats than eastern meadowlarks. Furthermore, Roseberry and Klimstra (1970) reported that the density of nesting eastern meadowlarks in pastures was inversely related to the intensity of grazing because grazing reduced vegetation structure. In contrast, Owens and Myres (1973) and Kantrud (1981) observed that grazing had little affect on western meadowlark abundance, although Kantrud and Kologiski (1982) noted that heavily grazed areas supported fewer western meadowlarks than lightly and moderately grazed grasslands. Thus, western meadowlarks may be more tolerant of mowing effects than eastern meadowlarks.

Common Yellowthroat

The mean arrival date of common yellowthroats in the spring of 1987 was 18 May ± 2.5 days ($n$ = 9). (Spring return dates were not recorded in 1986.) This corresponds well to the normal peak of migration in Iowa (Dinsmore et al. 1984).

The density of territorial male common yellowthroats was relatively low (Fig. 1), and yellowthroats were irregularly distributed among alfalfa fields. On 30 May, before mowing, the average density was only 12 ± 12 males/100 ha ($n$ = 11 fields). Males vacated territories after mowing and never returned. Similarly, Kantrud (1981) reported that common yellowthroat density was greatly reduced by even moderate grazing.

Compared with the alfalfa fields in general, yellowthroat territories had significantly taller vegetation and greater grass coverage (Tables 1, 3). Most territories included grass waterways. The preferred habitat of yellowthroats has been described as a mixture of dense herbaceous vegetation with or without shrubs or small trees (Stewart 1953, Johnston and Odum 1956, Hofslund 1959, Graber and Graber 1963, Kantrud 1982). Also, their distribution often coincides with that of moist soil; however, this may only reflect the presence of dense vegetation on such sites (Stewart 1953). Common yellowthroats generally are not considered true grassland species (Johnston and Odum 1956); rather, they inhabit the early seral stages of deciduous forests succession (Stewart 1953, Faanes and Andrew 1983). Alfalfa fields probably are only a secondary habitat for this species.

## Sedge Wren

The average spring return date for 3 male sedge wrens was 7 May $\pm$ 1.2 days. Dinsmore et al. (1984) reported that the peak of migration is mid-May. The density of sedge wrens was low and irregular in the first alfalfa crop, and the species never colonized the second alfalfa crop (Fig. 1). Similarly, Sample (1989) reported that all sedge wrens abandoned fields after they have been mowed.

Compared with the alfalfa fields in general, sedge wren territories were not significantly different. Although not readily evident from the vegetation characteristics measured in only 7 territories (Tables 1, 3), sedge wrens generally established their territories along drainage waterways. Vegetation of drainage waterways was generally composed of more grass and weedy vegetation (e.g., *Rumex* spp.) than the field in general. The preferred habitat of this species has been described as sedge (*Carex* spp.) and grass-covered areas surrounding wetlands (Walkinshaw 1935, Anonymous 1948). Skinner (1975) and Renken and Dinsmore (1987) also reported that the density of sedge wrens was greater in tall, rank grassland vegetation than short, sparse vegetation. Although generally associated with lowland meadows, sedge wrens will nest in drier upland areas (Tordoff and Young 1951). Tordoff and Young suggested that local climatic conditions may influence distribution, and during periods of greater than normal rainfall, yellowthroats may nest in areas otherwise considered too dry. The distribution of sedge wrens in my alfalfa fields may have been related to favorable soil moisture and microclimatic conditions present along drainage waterways.

Grasshopper Sparrow

I did not document the earliest arrival dates of grasshopper sparrows, but their peak abundance occurred during early May (Fig. 1). This peak agrees well with the peak of migration (Dinsmore et al. 1984).

Grasshopper sparrows attempted to breed in both the first and second alfalfa crops. The density of grasshopper sparrows was relatively high in early May (Fig. 1), but by 30 May, density had dropped markedly. For the first 3 weeks after mowing, grasshopper sparrow numbers increased again. Similarly, Renken (1983) reported that grasshopper sparrows colonized grasslands after cattle grazing ceased. The increase in abundance 4 weeks after mowing in my fields in 1987 was significant ($F = 10.51$; 1,4 df; $P = 0.03$), but when the data from both years were combined, the density before and after mowing was not significantly different (Table 2). In contrast to observations by Smith (1963, 1968), mowing caused grasshopper sparrows to abandon for the season some of my fields; in other fields, males colonized the second alfalfa crop where previously no males had been present. Forbush (1929) and George (1952) also reported that mowing caused grasshopper sparrows to abandon fields (sometimes permanently). Furthermore, Wiens (1973b) and Kantrud (1981) reported that grasshopper sparrow abundance was reduced by heavy grazing by cattle. Thus, it is probably more common for grasshopper sparrows to abandon mowed fields than suggested by Smith.

Mean vegetation characteristics of areas within grasshopper sparrow territories in the first alfalfa crop were not significantly different from those of the study plots in general (Tables 1, 3). Vegetation of grasshopper sparrow territories in the first alfalfa crop was measured during mid-May (Table 2); however, the number and location of territories was based on censuses conducted during early May. Thus, the nonsignificant results of the tests in first crop may have been because of differences between the vegetation at the time of territory establishment and the time when it was measured (see Whitmore 1979a). Used areas in the second alfalfa crop had short, sparse stands of vegetation with less forb coverage than that of the study fields in general (Tables 1, 3). Others have reported that grasshopper sparrows are generally most abundant in relatively open grasslands of low-to-medium height and density (Wiens 1969, 1973a,b; Tramontano 1971; Kantrud 1981; Whitmore 1981; Skinner et al. 1984). Bollinger (1988) reported that grasshopper sparrows were present in only 4 of 90 (4%) alfalfa fields in central New York. Smith (1963) noted that grasshopper sparrow density was low (13 pairs/100 ha) in dense stands of alfalfa. Similarly, Bollinger (1988) reported that grasshopper sparrows in alfalfa fields were most abundant in older (>10 years old) fields with short, sparse vegetation. Clumped vegetation (e.g., bunch grasses and alfalfa), rather than sod-forming vegetation, also has been reported to be an integral component of grasshopper sparrow territories (Smith 1963, Tramontano 1971, Blankespoor 1980, Whitmore 1981, Janes 1983).

The decline in male grasshopper sparrow density in the first alfalfa crop after early May and in the second alfalfa crop 3 weeks after mowing may reflect a threshold maximum in alfalfa height/density that the birds prefer. Tramontano (1971) reported that foraging grasshopper sparrows searched the basal periphery of grass clumps for prey; however, similar clumps were not investigated for prey where they formed a continuous wall of stems (i.e., reached a threshold maximum). Thus, it is possible that alfalfa fields had reached this threshold maximum when grasshopper sparrows started to abandon my fields. Assuming that alfalfa height increased linearly between periods when vegetation was measured in both the first and second alfalfa crops, then grasshopper sparrow density began to decline when alfalfa was about 30 cm tall. Whitmore (1979b) reported that grasshopper sparrow abundance was inversely related to vegetation density (structure). Furthermore, Skinner (1975) compared grasshopper sparrow abundance in grasslands ranging from 0 to >30 cm tall (effective height) and reported that grasshopper sparrows were most abundant in fields having grass between 10 and 30 cm tall. Wiens (1973a) observed that males displayed strong site fidelity as long as they were mated. Thus, when alfalfa height surpassed about 30 cm, it was probably the unmated males and unsuccessful pairs that abandoned the fields.

Mourning Dove

In southern Iowa, the peak of spring mourning dove migration usually occurs in late March (Dinsmore et al. 1984), before I began censuses. Mourning doves occurred in low density (Table 2) and were irregularly distributed among fields in the first alfalfa crop. Downing (1959) also reported finding few mourning doves nesting in Oklahoma grasslands (about 4 ground nests[pairs]/100 ha). Mourning dove nest density is greater in trees than on the ground, suggesting that trees are the preferred nesting substrate (Cowan 1952, Downing 1959, Hanson and Kossack 1963, Olson 1980). Although dove density in the second alfalfa crop was not significantly different from those in the first crop (Table 2), doves did not nest in the second crop. Easterla (1962) and Karr (1968) reported that doves were less likely to build nests on the ground late in the nesting season. Likewise, Olson (1980) reported that the greatest number of ground nests were active in short-grass prairie during early June. Thus, doves probably were less likely to initiate new nests in the second alfalfa crop because they may have relocated to trees and shrubs.

Vesper Sparrow

The peak of the vesper sparrow migration in Iowa is early April (Dinsmore et al. 1984), before I began my censuses. Vesper sparrows attempted to breed in both the first and second alfalfa crops, although their density was low (Fig. 1, Table 2). The difference in vesper sparrow numbers before and after the first mowing was not statistically significant. Density estimates reported for vesper sparrow are highly variable, ranging from 143 to 215 pairs/100 ha (Berger 1968) to 3 pairs/100 ha (Dambach and Good 1940).

The mean vegetation characteristics of areas used by vesper sparrows in the first and second alfalfa crop were not significantly different from the study plots in general (Tables 1, 3), but my sample size was small. Vesper sparrows generally are more numerous in areas with sparser vegetation (e.g., reclaimed surface mines [Wray et al. 1982], row crop fields [Rodenhouse and Best 1983]) than in alfalfa or similar fields (Dambach and Good 1940, Harrison 1974, present study). Wiens (1969) reported that vegetation in vesper sparrow territories was shorter and less dense than that in unoccupied areas of grasslands. In comparison, Reed (1986) noted that the vegetation in territories was shorter and denser than that in unoccupied portions of an upland grassy area. Rotenberry and Wiens (1980) compared vesper sparrow densities in habitats ranging from shrubsteppe to tallgrass prairie, and reported that they were most abundant at montane sites characterized by a dense cover of low forbs. Also, elevated song perches may be a territory requisite (Berger 1968, Schaid et al. 1983, Best and Rodenhouse 1984).

Like grasshopper sparrows, vesper sparrows may be sensitive to vegetation changes that occur after territories are established. Vesper sparrow density declined during May and 3 weeks after mowing in the second alfalfa crop (Fig 1). Whitmore (1979b) reported that vesper sparrow abundance was inversely related to vegetation density (structure). Furthermore, Rodenhouse and Best (1983) and Perritt and Best (1989) observed that, as the crop (corn and soybean) canopy closed, fields generally became unsuitable for nesting. Thus, unmated males and unsuccessful pairs probably abandon fields as the vegetation becomes tall and dense.

## Management Implications

The suitability of alfalfa fields for breeding birds is influenced primarily by the occurrence of mowing and its effect on vegetation structure. To evaluate the contribution of hayfields to the conservation of grassland birds, wildlife managers must identify both species benefited and species harmed by mowing (Ryan 1986). I reported that dickcissel, red-winged blackbird, and common yellowthroat populations were reduced significantly after the removal of vegetation. Furthermore, I suggest that the loss of sedge wrens and mourning doves from fields after mowing was biologically significant, although it was not statistically significant. Common yellowthroats, along with sedge wrens, used only selected areas within alfalfa fields (i.e., waterways), but when these areas were mowed with the rest of the field, the fields were abandoned. Mourning doves nested solely in the first alfalfa crop, and they may have initiated new nests in trees and shrubs rather than on the ground after fields were mowed. In contrast, vesper and grasshopper sparrows seemed to increase after the removal of vegetation. Western meadowlark abundance seemed unrelated to vegetation changes induced by mowing, at least when their territories included adjacent unmowed habitat.

The abundance of dickcissels and redwings seemed to be positively related to vegetation density throughout the period of alfalfa growth. In contrast, vesper sparrow and grasshopper sparrow abundance evidently was positively related to vegetation structure until the alfalfa reached a height of about 30 cm; above 30 cm, the abundance of these species seemed to be inversely related to vegetation height (Table 1, Fig. 1). Western meadowlark, common yellowthroat, sedge wren, and mourning dove abundance seemed unrelated to vegetation growth.

Although the negative effects of mowing on birds are easily recognized (i.e., fewer species and lower overall bird abundance), a solution to the problem is far more difficult, if not impossible, to achieve on most privately managed land. Solutions such as delayed mowing contradict modern forage management practices. Highest yields are obtained by harvesting alfalfa when it reaches late stages of development, but the highest-quality forage is obtained by harvesting during early stages (e.g., immediately before or during the early-bloom stage; Barnes and Sheaffer 1985). Most forage managers reach a compromise between harvesting for maximum quality and quantity by attempting to harvest the crop when it has the greatest amount of digestible nutrients per unit area. In Iowa, this generally results in harvesting the first alfalfa crop during early June when it begins flowering and then mowing the alfalfa 2 additional times at about 5 1/2-week intervals (Iowa Crop and Livestock Rep. Serv. 1987). Obviously, the needs of birds attempting to nest in hayfields are neglected when hay production goals are developed.

Forage production on private lands has and probably will continue to intensify (i.e., greater production, new cultivars, and earlier mowing) in the Midwest (Natl. Res. Counc. 1982, Barnes and Sheaffer 1985). With the advent of new cultivars, mowing occurs earlier in the spring (Warner and Etter 1989). Modern alfalfa varieties can be mowed 4 times in Iowa and still maintain good yields (Wedin 1983). As a result, bird productivity in alfalfa fields probably has been greatly reduced and, in many instances, completely eliminated (e.g., Labisky 1957, Gates 1965, Gates and Hale 1975, Bollinger 1988, Warner and Etter 1989, Section II).

Unlike most privately managed hayfields, grasslands entered into federal land retirement programs (e.g., Conservation Reserve Program authorized by the Food Security Act of 1985) can benefit birds nesting in grasslands (e.g., Edwards 1984, Berner 1988). In light of the negative effects of mowing on most birds nesting in hayfields, the grasslands retired through federal programs may provide areas suitable for more species and a higher overall density of nongame birds than hayfields. Allowing mowing during the nesting season, however, will negate these potential benefits.

Ironically, mowing is often viewed as a wildlife management tool on public property. Strassman (1987) reported that 12,021 ha of grassland were mowed on 63 refuges, and most mowing occurred during the main part of the nesting period. Furthermore, Strassman reported that additional land is mowed during drought years to supply emergency hay. My results support Strassman's conclusion that mowing does not accommodate the needs of most nesting birds and is contradictory to the goals of wildlife conservation on public lands.

# LITERATURE CITED

Adams, R. J., Jr., G. A. McPeek, and D. C. Evers. 1988. Bird population changes in Michigan, 1966-1985. Jack-Pine Warbler 66:71-86.

Albers, P. H. 1975. Avian habitat selection in a region of intensive agriculture: The red-winged blackbird. Ph.D. Thesis. Univ. Mich., Ann Arbor. 189 pp.

Albers, P. H. 1978. Habitat selection by breeding red-winged blackbirds. Wilson Bull. 90:619-634.

Anonymous. 1948. *Cistothorus platensis stellaris* (Naumann), Short-billed marsh wren. Pages 265-276 *in* A. C. Bent, ed. Life histories of North American nuthatches, wrens, thrashers and their allies. U.S. Natl. Mus. Bull. 195.

Applegate, R. D., and A. G. Willms. 1987. Distribution and population trend of western meadowlarks in Illinois. Prairie Nat. 19:145-148.

Barnes, D. K., and C. C. Sheaffer. 1985. Alfalfa. Pages 89-97 *in* M. E. Heath, R. F. Barnes, and D. S. Metcalfe, eds. Forages: The science of grassland agriculture. Fourth ed. Iowa State Univ. Press, Ames.

Barnes, R. F., and C. H. Gordon. 1972. Feeding value and on-farm feeding. Pages 601-630 *in* C. H. Hanson, ed. Alfalfa science and technology. Am. Soc. Agron., Madison, Wisc.

Basore, N. S., L. B. Best, and J. B. Wooley, Jr. 1986. Arthropod availability to pheasant broods in no-tillage fields. Wildl. Soc. Bull. 15:229-233.

Beer, J. R., and D. Tibbitts. 1950. Nesting behavior of the red-wing blackbird. Flicker 22:61-77.

Berger, A. J. 1968. *Pooecetes gramineus* (Gmelin), Eastern vesper sparrow. Pages 868-882 *in* O. T. Austin, ed. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. U.S. Natl. Mus. Bull. No. 237, part 2.

Berner, A. H. 1988. Federal pheasants--impacts of federal agricultural programs on pheasant habitat, 1934-1985. Pages 45-93 *in* D. L. Hallett, W. R. Edwards, and G. V. Burger, eds. Pheasants: Symptoms of wildlife problems on agricultural lands. North Cent. Sect. Wildl. Soc., Bloomington, Ind.

Besser, J. F. 1985. Breeding blackbird populations in Iowa. Iowa Bird Life 55:35-42.

Best, L. B., and N. L. Rodenhouse. 1984. Territory preference of vesper sparrows in cropland. Wilson Bull. 96:72-82.

Blakley, N. R. 1976. Successive polygyny in upland nesting redwinged blackbirds. Condor 78:129-133.

Blankespoor, G. W. 1980. Prairie restoration: Effects on nongame birds. J. Wildl. Manage. 44:667-672.

Bollinger, E. K. 1988. Breeding dispersion and reproductive success of bobolinks in an agricultural landscape. Ph.D. Thesis. Cornell Univ., Ithaca, N.Y. 189 pp.

Buhnerkempe, J. E. 1979. Habitat utilization and partitioning within a community of nesting grassland birds. M.S. Thesis. East. Ill. Univ., Charleston. 58 pp.

Buxton, D. R., J. S. Hornstein, W. F. Wedin, and G. C. Marten. 1985. Forage quality in stratified canopies of alfalfa, birdsfoot trefoil, and red clover. Crop Sci. 25:273-279.

Case, M., and O. H. Hewitt. 1963. Nesting and productivity of the red-winged blackbird in relation to habitat. Living Bird 2:7-20.

Castrale, J. S. 1985. The Breeding Bird Survey in Indiana: Eighteen years of overlooked data. Ind. Audubon Q. 63:15-30.

Council on Environmental Quality. 1988. Birdlife of the United States. Pages 1-64 in Environmental quality. Seventeenth annual report of the U.S. Council on Environmental Quality, Washington, D.C.

Cowan, J. B. 1952. Life history and productivity of a population of western mourning doves in California. Calif. Fish and Game 38:505-510.

Dambach, C. A., and E. E. Good. 1940. The effect of certain land use practices on populations of breeding birds in southwestern Ohio. J. Wildl. Manage. 4:63-76.

Darley, J. A. 1982. Territoriality and mating behavior of the male brown-headed cowbird. Condor 84:15-21.

Dinsmore, J. J., T. H. Kent, D. Koenig, P. C. Petersen, and D. M. Roosa. 1984. Iowa birds. Iowa State Univ. Press, Ames. 355 pp.

Downing, R. L. 1959. Significance of ground nesting by mourning doves in northwestern Oklahoma. J. Wildl. Manage. 23:117-118.

Easterla, D. A. 1962. Avifauna of Tucker Prairie. M.A. Thesis. Univ. Mo., Columbia. 132 pp.

Edwards, W. R. 1984. Early ACP and pheasant boom and bust!- historical perspective with rationale. Pages 71-83 in R. T. Dumke, R. B. Stiehl, and R. B. Kahl, eds. Perdix III: Gray partridge and ring-necked pheasant workshop. Wisc. Dep. Nat. Resour., Madison.

Emlen, J. T., and J. A. Wiens. 1965. The dickcissel invasion of 1964 in southern Wisconsin. Passenger Pigeon 27:51-59.

Faanes, C. A., and J. M. Andrew. 1983. Avian use of forested habitats in the Pembina Hills of northeastern North Dakota. U.S. Fish and Wildl. Serv. Resour. Publ. 151. 24 pp.

Forbush, E. H. 1929. Birds of Massachusetts and other New England states. Part III. Mass. Dep. Agric., Boston. 466 pp.

Gates, J. M. 1965. Duck nesting and production on Wisconsin farmlands. J. Wildl. Manage. 29:515-523.

Gates, J. M., and J. B. Hale. 1974. Seasonal movement, winter habitat use, and population distribution of an east central Wisconsin pheasant population. Wisc. Dep. Nat. Resour. Tech. Bull. 76. 55 pp.

Gates, J. M., and J. B. Hale. 1975. Reproduction of an east central Wisconsin pheasant population. Wisc. Dep. Nat. Resour. Tech. Bull. 85. 70 pp.

George, J. L. 1952. The birds on a southern Michigan farm. Ph.D. Thesis. Univ. Mich., Ann Arbor. 413 pp.

Graber, R. R., and J. W. Graber. 1963. A comparative study of bird populations in Illinois, 1906-1909 and 1956-1958.

Ill. Nat. Hist. Surv. Bull. 28:383-528.

Greub, L. J., and W. F. Wedin. 1971. Leaf area, dry-matter accumulation, and carbohydrate reserves of alfalfa and birdsfoot trefoil under a three-cut management. Crop Sci. 11:341-344.

Gross, A. O. 1921. The dickcissel (Spiza americana) of the Illinois prairies. Auk 38:1-26.

Hanson, H. C., and C. W. Kossack. 1963. The mourning dove in Illinois. Ill. Dep. Conserv. Tech. Bull. 2. 133 pp.

Hartman, F. E., and R. Fisher. 1984. Pheasant nesting success with delayed hay mowing in Pennsylvania: Preliminary results. Pages 110-116 in R. T. Dumke, R. B. Stiehl, and R. B. Kahl, eds. Perdix III: Gray partridge and ring-necked pheasant workshop. Wisc. Dep. Nat. Resour., Madison.

Harrison, K. G. 1974. Aspects of habitat selection in grassland birds. M.A. Thesis. West. Mich. Univ., Kalamazoo. 82 pp.

Hofslund, P. B. 1959. A life history study of the yellowthroat, Geothlypis trichas. Proc. Minn. Acad. Sci. 27:144-174.

Holcomb, L. C., and G. Twiest. 1968. Ecological factors affecting nest building in red-winged blackbirds. Bird-Banding 42:1-17.

Iowa Crop and Livestock Reporting Service. 1985. Iowa Agricultural Statistics. Iowa Dep. Agric., Des Moines, Iowa, and U.S. Dep. Agric. Stat. Rep. Serv., Washington, D.C. 177 pp.

Iowa Crop and Livestock Reporting Service. 1987. Iowa crops and weather. Iowa Dep. Agric., Des Moines, Iowa, and U.S. Dep. Agric. Stat. Rep. Serv., Washington, D.C., May-August Issues.

Iowa Crop and Livestock Reporting Service. 1989. Iowa crop report. Iowa Dep. Agric., Des Moines, Iowa, and U.S. Dep. Agric. Stat. Rep. Serv. 89(1).

Janes, S. W. 1983. Status, distribution, and habitat selection of the grasshopper sparrow in Morrow County, Oregon. Murrelet 64:51-54.

Johnston, D. W., and E. P. Odum. 1956. Breeding bird populations in relation to plant succession on the piedmont of Georgia. Ecology 37:50-62.

Kantrud, H. A. 1981. Grazing intensity effects on the breeding avifauna of North Dakota native grasslands. Can. Field-Nat. 95:404-417.

Kantrud, H. A. 1982. Maps of distribution and abundance of selected species of birds on uncultivated native upland grasslands and shrubsteppe in the Northern Great Plains. U.S. Fish and Wildl. Serv. FWS/OBS-82/31. 31 pp.

Kantrud, H. A., and R. L. Kologiski. 1982. Effects of soils and grazing on breeding birds of uncultivated upland grasslands of the Northern Great Plains. U.S. Fish and Wildl. Serv. Res. Rep. 15. 33 pp.

Karr, J. R. 1968. Habitat and avian diversity on strip-mined lands in east-central Illinois. Condor 70:348-357.

Krapu, G. L. 1978. Productivity of red-winged blackbirds in prairie pothole habitat. Iowa Bird Life 48:24-30.

Labisky, R. F. 1957. Relation of hay harvesting to duck nesting under a refuge-permittee system. J. Wildl. Manage. 21:194-200.

Lanyon, W. E. 1957. The comparative biology of the meadowlark (Sturnella) in Wisconsin. Publ. Nuttall Ornithol. Club 1:1-67.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. Trans. N. Am. Wildl. Conf. 23:215-227.

Monahan, M. W. 1977. Determinants of male pairing success in the redwinged blackbird (Agelaius phoeniceus): A multivariate, experimental analysis. Ph.D. Thesis. Ind. Univ., Bloomington. 169 pp.

Monroe, B. L., Jr. 1967. Dickcissel populations in southwestern Michigan. Jack-Pine Warbler 45:124-127.

National Oceanic and Atmospheric Administration. 1987. Local climatological data, annual summaries for 1987, part III - Central region. Natl. Climatic Cent., Asheville, N.C.

National Research Council. 1982. Impacts of emerging agricultural trends on fish and wildlife habitat. Natl. Acad. Press, Washington, D.C. 303 pp.

Nelson, C. J. and D. Smith. 1968. Growth of birdsfoot trefoil and alfalfa. III. Changes in carbohydrate reserves and growth analysis under field conditions. Crop Sci. 8:25-28.

Olson, T. E. 1980. Mourning doves and land use changes in eastern Colorado. M.S. Thesis. Colo. State Univ., Fort Collins. 119 pp.

Owens, R. A., and M. T. Myres. 1973. Effects of agriculture upon populations of native passerine birds of an Alberta fescue grassland. Can. J. Zool. 51:697-713.

Peek, F. W. 1971. Seasonal change in the breeding behavior of the male red-winged blackbird. Wilson Bull. 83:383-395.

Perritt, J. E., and L. B. Best. 1989. Effects of weather on the breeding ecology of vesper sparrows in Iowa crop fields. Am. Midl. Nat. 121:355-360.

Reed, J. M. 1986. Vegetation structure and vesper sparrow territory location. Wilson Bull. 98:144-147.

Renken, R. B. 1983. Breeding bird communities and bird-habitat associations on North Dakota Waterfowl Production Areas of three habitat types. M.S. Thesis. Iowa State Univ., Ames. 90 pp.

Renken, R. B., and J. J. Dinsmore. 1987. Nongame bird communities on managed grasslands in North Dakota. Can. Field-Nat. 101:551-557.

Robbins, C. S. 1970. Recommendations for an international standard for a mapping method in bird census work. Audubon Field Notes 24:723-726.

Robbins, C. S. 1981. Bird activity levels related to weather. Pages 301-310 in C. J. Ralph and J. M. Scott, eds. Estimating the number of terrestrial birds. Stud. Avian Biol. 6.

Robbins, C. S., D. Bystrak, and P. H. Geissler. 1986. The Breeding Bird Survey: Its first fifteen years, 1965-1979. U.S. Fish Wildl. Serv. Resour. Publ. 157. 196 pp.

Robbins, S. 1982. Wisconsin's Breeding Bird Survey results: 1966-1980. Passenger Pigeon 44:97-119.

Robertson, R. J. 1973. Optimal niche space of the red-winged blackbird: Spatial and temporal patterns of nesting activity and success. Ecology 54:1085-1093.

Rodenhouse, N. L., and L. B. Best. 1983. Breeding ecology of vesper sparrow in corn and soybean fields. Am. Midl. Nat. 110:265-275.

Roseberry, J. L., and W. D. Klimstra. 1970. The nesting ecology and reproductive performance of the eastern meadowlark. Wilson Bull. 82:241-267.

Rotenberry, J. T., and J. A. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: A multivariate analysis. Ecology 61:1228-1250.

Ryan, M. R. 1986. Nongame management in grassland and agricultural ecosystems. Pages 117-136 in J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the Midwest: A developing art. Book Crafters, Chelsea, Mich.

Sample, D. W. 1989. Grassland birds in southern Wisconsin: Habitat preference, population trends, and response to land use changes. M.S. Thesis. Univ. Wisc., Madison. 588 pp.

SAS Institute Inc. 1985. SAS user's guide: Statistics, Version 5 Edition. SAS Institute Inc. Cary, N.C. 956 pp.

Sayre, M. W., T. S. Baskett, and K. C. Sadler. 1980. Radio telemetry studies of the mourning dove in Missouri. Mo. Dep. Conserv. Terr. Ser. 9. 17 pp.

Schaid, T. A., D. W. Uresk, W. L. Tucker, and R. L. Linder. 1983. Effects of surface mining on the vesper sparrow in the northern Great Plains. J. Range Manage. 36:500-503.

Sherwood, M. A. 1980. Soil survey of Adair County, Iowa. U.S. Dep. Agric., Soil Conserv. Serv., Washington, D.C. 146 pp.

Skinner, R. M. 1975. Grassland use patterns and prairie bird populations in Missouri. Pages 171-180 in M. K. Wali, ed. Prairie: A multiple view. Univ. North Dakota

Press, Grand Forks.

Skinner, R. M., T. S. Baskett, and M. D. Blenden. 1984. Bird habitat on Missouri prairies. Mo. Dep. Conserv. Terr. Ser. 14 37 pp.

Smith, R. L. 1963. Some ecological notes on the grasshopper sparrow. Wilson Bull. 75:159-165.

Smith, R. L. 1968. Ammodramus savannarum (Gmelin), Grasshopper sparrow. Pages 725-745 in O. T. Austin, ed. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. U.S. Natl. Mus. Bull. 237, Part 2.

Stewart, R. E. 1953. A life history study of the yellow-throat. Wilson Bull. 65:99-115.

Strassman, B. I. 1987. Effects of cattle grazing and haying on wildlife conservation at national wildlife refuges in the United States. Environ. Manage. 11:35-44.

Tate, J., Jr. 1986. The blue list for 1986. Am. Birds. 40:227-236.

Tordoff, H. B., and G. P. Young. 1951. Short-billed marsh wren breeding in Kansas. Wilson Bull. 63:44-45.

Tramontano, J. P. 1971. Summer foraging behavior of sympatric Arizona grassland sparrows. Ph.D. Thesis. Univ. Ariz., Tucson. 65 pp.

Walkinshaw, L. H. 1935. Studies of the short-billed marsh wren (Cistothorus stellaris) in Michigan. Auk 52:362-369.

Warner, R. E., and S. L. Etter. 1989. Hay cutting and the survival of pheasants: A long-term perspective. J. Wildl. Manage. 52:455-461.

Wedin, W. F. 1983. Crop rotation designs. Pages 27-31 in R. B. Dahlgren, ed. Proceedings of the management alternatives for biological farming workshop. Iowa Coop. Fish and Wildl. Res. Unit, Iowa State Univ., Ames.

Whitmore, R. C. 1979a. Temporal variation in the selected habitats of a guild of grassland sparrows. Wilson Bull. 91:592-598.

Whitmore, R. C. 1979b. Short-term change in vegetation structure and its effect on grasshopper sparrows in West

Virginia. Auk 96:621-625.

Whitmore, R. C. 1981. Structural characteristics of grasshopper sparrow habitat. J. Wildl. Manage. 45:811-814.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithol. Monogr. 8:1-93.

Wiens, J. A. 1973a. Interterritorial habitat variation in grasshopper and savannah sparrows. Ecology 54:877-884.

Wiens, J. A. 1973b. Pattern and process in grassland bird communities. Ecol. Monogr. 43:237-270.

Wiens, J. A., and J. T. Emlen. 1966. Post-invasion status of the dickcissel in southern Wisconsin. Passenger Pigeon 11:63-69.

Wray, T., II, K. A. Strait, and R. C. Whitmore. 1982. Reproductive success of grassland sparrows on a reclaimed surface mine in West Virginia. Auk 99:157-164.

Wright, P. L., and M. H. Wright. 1944. The reproductive cycle of the male red-winged blackbird. Condor 46:46-59.

Zaletel, L. R., and J. J. Dinsmore. 1985. Breeding bird populations in Iowa, 1968-1980. Proc. Iowa Acad. Sci. 92:85-94.

Zimmerman, J. L. 1971. The territory and its density dependent effect on Spiza americana. Auk 88:591-612.

Zimmerman, J. L. 1979. Ten year summary of the Kansas breeding-bird survey: Trends. Kans. Ornithol. Soc. Bull. 30:17-19.

# SECTION II. EFFECTS OF MOWING ON NONGAME BREEDING BIRD REPRODUCTION IN ALFALFA FIELDS

## ABSTRACT

The reproductive success of nongame birds nesting in the first and second alfalfa (*Medicago sativa*) crops was studied in 1986 and 1987. Hay mowing was the main cause of nest failures, accounting for 36% of all nest losses. Mowing had the greatest effect on dickcissels (*Spiza americana*) and red-winged blackbirds (*Agelaius phoeniceus*); 50 and 41% of their nests, respectively, were destroyed by mowing operations. Bird productivity in alfalfa fields was estimated to be below levels needed to compensate for nest failures. Thus, alfalfa fields act like ecological traps in that birds are attracted to the fields, but most nest attempts are unsuccessful. Factors that either hasten the mowing schedule or delay nesting are especially detrimental to nest success. Bird productivity probably could be improved by delayed mowing; however, the management objectives of private landowners generally prevent delayed mowing.

# INTRODUCTION

Alfalfa (Medicago sativa) is distributed throughout the world, and in the U.S., it is grown in every state. About two-thirds of the estimated 11 million ha of alfalfa grown annually in the U.S. is harvested in the north central states (Barnes and Sheaffer 1985). About 640,000 and 586,800 ha of alfalfa was harvested in Iowa during 1986 and 1987, respectively (Iowa Crop Rep. Serv. 1987, 1989).

When hay mowing occurs, fields of tall, dense alfalfa are reduced suddenly to short, sparse stubble. Consequently, the amount of vegetation available to nesting birds is drastically altered, and nest success is affected as the alfalfa is harvested. Mowing reduces the number of nesting species and overall bird abundance in alfalfa fields (Section I). The negative effects of mowing on nongame bird productivity, however, were largely unknown before my study, although mowing during the nesting season was generally assumed to reduce bird productivity (Tabor 1947, Sealy 1976, Robbins 1982, Ryan 1986).

Unlike natural situations, the difference between nest success and failure in alfalfa fields is often determined by the timing of mowing (Labisky 1957, Milonski 1958, Gates 1965, Gates and Hale 1975, Warner and Etter 1989, Bollinger 1988). For example, delaying mowing in the spring by a few days can greatly increase ringed-neck pheasant (Phasianus *colchicus*) nest success (Hartman and Fisher 1984, Warner and Etter 1989).

Many birds commonly found in alfalfa fields have declined recently. Analyses of regional population trends using Breeding Bird Survey data from the Midwest and Great Plains have suggested that dickcissels (*Spiza americana*), meadowlarks (*Sturnella* spp.), and grasshopper sparrows (*Ammodramus savannarum*) have declined (Zimmerman 1979, Robbins 1982, Castrale 1985, Zaletel and Dinsmore 1985, Robbins et al. 1986, Adams et al. 1988). Independent census data provide additional evidence that populations of these species have declined (Anon. 1983, Applegate and Willms 1987). Although direct evidence is lacking, mowing has been implicated as contributing to these declines (Robbins 1982, Bollinger 1988).

I investigated the effect of current forage management practices on breeding birds; specifically, I determined the effects of hay mowing (and subsequent harvest) on nest success and bird productivity in alfalfa fields.

## STUDY SITE AND METHODS

My study was conducted in Adair County in southwestern Iowa during the spring and summer of 1986 and 1987. Ninety-eight percent of Adair County is farmland, and about 64% is cultivated (Iowa Crop and Livestock Rep. Serv. 1985). Corn and soybeans are the major crops (49% of the county), with about 7% of the county planted to hay (alfalfa and alfalfa-grass mixtures). The topography of the county is gently rolling. The climate is subhumid and continental, with an average summer temperature of 23 C. The growing season extends from April through September, and the county normally receives nearly 75% of its annual precipitation during this period (Sherwood 1980). South-central Iowa (Des Moines) received above normal annual precipitation ($\bar{x}$ = 81 cm, 1958-1987) during both 1986 and 1987 (108 and 94 cm, respectively) (Natl. Oceanic and Atmos. Adm. 1987). Precipitation during the growing season also was greater than normal ($\bar{x}$ = 59 cm, 1958-1987) both years (81 and 64 cm, respectively).

Six alfalfa fields were selected for study each year, 5 of which were used both years. The 7.5-ha study plots usually were square (275 X 275 m) and were situated within alfalfa fields such that they were surrounded by a 50-m wide buffer zone of alfalfa. (One study plot was 225 X 350 m.) Buffer zones were maintained around the plots to exclude from my study area species attracted to fencerow habitats rather than the interior of the fields (i.e., reduce edge effects). Study plots were gridded throughout with surveyor flags, placed at 25-m intervals, to help map nest locations. The mowing date recorded for each plot was the day when all or most of the plot was mowed. All alfalfa fields were privately owned, and owners mowed according to their own schedules, independent of my research activities. State crop harvest statistics (Iowa Crop and Livestock Rep. Serv. 1987) were used to calculate statewide average mowing dates for alfalfa (Warner and Etter 1989).

Study plots were searched weekly for nests from mid-May to mid-July in the first and second alfalfa crops by using a rope dragging technique (Rodenhouse and Best 1983). Nests also were located by observing adults attending the nest or young. Active nests were marked by flags placed 1 to 2 m north of the nest and were visited every 3-4 days until their outcome had been determined. Clutches were judged complete when the number of eggs in the nests did not vary between visits.

Nests fledging at least 1 host nestling were considered successful. Nest failures were attributed to weather when eggs (usually intact) or nestlings were found beneath the nest; these losses were associated with inclement weather. Failures were attributed to parasitism by the brown-headed cowbird (*Molothrus ater*) when the nest was deserted after cowbird eggs had been deposited in it or when a nest fledged only cowbird young. Cowbirds generally only lay eggs in active nests (Thompson and Gottfried 1976); thus, most of the parasitism observed probably occurred before abandonment. Nests were considered lost to predators if the nest contents (eggs or young) had been removed from the nest. Sometimes the nest was left intact; at other times it was physically disturbed. Nests abandoned by the adults but otherwise having the same contents as during the previous visit were considered to be deserted due to unknown causes. Nest abandonment was attributed to researchers when I was certain that my activities near the nest had caused failures (e.g., stepping on nests or dislodging nest contents). Finally, all nests active before mowing but not after mowing were considered lost to harvesting equipment (e.g., tractors, mowers, balers, and wagons).

Nest success estimates were based on the number of days of nest exposure (Mayfield 1975). When the day that the nest failed was unknown, I assumed that the nest failed on the day midway between the date when the nest failure was first recorded and the date of the previous nest visit. I assumed a constant survival rate throughout the nesting cycle (period from beginning of egg laying to fledgling) because my sample sizes was too small to determine otherwise (Klett and Johnson 1982). The microcomputer program MICROMORT (Heisey and

Fuller 1985) was used to calculate daily survival and mortality (failure) rates and their variances. Nests of unknown fate and nests failing because of human disturbance were deleted from analyses. Daily nest survival or mortality rates were compared among species using a 2-tailed Z-test. The frequency of cowbird parasitism in the first and second alfalfa crops was compared using a chi-square test. Null hypotheses were rejected at $P \leq 0.05$. When possible, I compared my nest success values with other estimates derived using the Mayfield method; thus, nest success values in the text are Mayfield estimates unless indicated otherwise. In those instances in the text when I cite a Mayfield nest success estimate but do not perform a Z-test (i.e., compare to my estimate), it is because I was unable to determine the daily survival rate and its variance from the literature. Thus, I was unable to compare statistically success estimates. Also, throughout the text and in tables, mean values are reported $\pm 1$ standard deviation.

Calculation of bird productivity in alfalfa fields followed Rodenhouse and Best (1983) in which annual productivity (fledglings/territory) = (fledglings/successful nest) * (number of successful nests/territory). My estimate of the number of territories (used to calculate the number of successful nests/territory) differed from that of Rodenhouse and Best because the number of territories of most species varied throughout my study period (Section I, Table 2). For those species present in both the first and second alfalfa crops (dickcissels, grasshopper sparrows, vesper sparrows [Pooecetes gramineus], and western meadowlarks [Sturnella neglecta]), I estimated the number of territories by computing an average of the number of territories recorded for these species on 30 May and 4 weeks after mowing. For species nesting in the first alfalfa crop only (red-winged blackbirds [Agelaius phoeniceus] and mourning doves [Zenaida macroura]), I used the number of territories present on 30 May. My estimates of productivity probably are overestimated because they do not reflect fledgling (11-14 days old) mortality caused by mowing ($\geq$50%, Bollinger 1988). Bollinger also suggested that older fledglings (>14 days old) experienced higher than normal mortality. Furthermore, my estimates of productivity did not account for instances of polygyny; thus, productivity was overestimated by an unknown amount in polygynous species. Polygamy was observed in red-winged blackbirds and dickcissels, but the incidence of polygyny was low for dickcissels (e.g., in 1987, only 2 of 90 [2%] dickcissels with at least 50% of their territory on my plots were known to be polygamous), thus my productivity estimates probably were biased very little for this species. Polygyny also has been reported for western meadowlarks (53%, Lanyon 1957) and common yellowthroats (*Geothlypis trichas*) (9%, Stewart 1953).

# RESULTS AND DISCUSSION

## Vegetation Changes

Throughout the growing season, alfalfa fields are in a continuous state of regrowth (Section I). The vegetation in fields changes from short and sparse to tall and dense in the spring and after each mowing. This cycle occurs at least 3 times in the growing season. The dates of the first and second cuttings of alfalfa were not significantly different between the two years of my study (1986: first mowing - 11 June $\pm$ 7 days, second mowing - 19 July $\pm$ 5 days; 1987: first mowing - 1 June $\pm$ 8 days, second mowing - 9 July $\pm$ 11 days) and were comparable to the statewide mean dates (first mowing - 12 June, second mowing - 19 July; 5-year average, 1982-86; Iowa Crop and Livestock Rep. Serv. 1987). By 21 June 1987, however, favorable weather had allowed Iowa farmers to harvest 95% of their first alfalfa crop. This was well ahead of the 1986 harvest (83%) and the 5-year statewide average of 75% at this same date (Iowa Crop and Livestock Rep. Serv. 1987). The mean interval between the first and second cuttings was 39 $\pm$ 6 days and did not differ between the 2 years (statewide mean interval - 37 days).

## Bird Community Changes

Eight nongame bird species, in addition to ringed-neck pheasants and brown-headed cowbirds, established breeding territories in the alfalfa study fields during 1986-87 (Section I). Before mowing (30 May), all 8 species attempted to breed on the alfalfa fields; after mowing, only 4 attempted to breed. Dickcissels, grasshopper sparrows, western meadowlarks, and vesper sparrows nested in both the first and second alfalfa crops. Mourning doves, red-winged blackbirds, sedge wrens (*Cistothorus platensis*) and common yellowthroats established territories only in first crop.

## Nest Success

One hundred twelve nests were found with at least 1 host egg or nestling (active nests) (Table 1); almost all (107) of these were located before the eggs hatched. Also, 12 nests (8 red-winged blackbird and 4 dickcissel) were found completed but empty, and 4 partially built red-winged blackbird nests were found each containing a cowbird egg. Although these 16 nests may have been deserted because of predators, researchers, or cowbirds, they were eliminated from analyses because they were not considered active nests. Moreover, redwings frequently desert both partially constructed nests and completed nests without eggs (e.g., Case and Hewitt 1963, Goddard and Board 1967, Brown and Goertz 1978). Nests were found for all of the territorial species except sedge wrens; dickcissel and red-winged blackbird nests were most common (Table 1).

Although red-winged blackbirds nested only in the first

Table 1. Fate (number) of nests found in first and second crop alfalfa fields in 1986-87

| Species | Nests found[a] | Cowbird parasitism | Abandoned-unknown causes | Destroyed | | | Successful |
|---|---|---|---|---|---|---|---|
| | | | | Predators | Mowing | Weather | |
| Red-winged blackbird | 41 | 4 | 2 | 12 | 17 | 2 | 4 |
| Dickcissel | 34 | 7 | 0 | 6 | 17 | 0 | 4 |
| Vesper sparrow | 10 | 0 | 0 | 5 | 1 | 0 | 4 |
| Western meadowlark | 9 | 0 | 2 | 5 | 1 | 0 | 1 |
| Mourning dove | 6 | 0 | 2 | 1 | 1 | 0 | 2 |
| Grasshopper sparrow | 5 | 0 | 0 | 3 | 0 | 0 | 2 |
| Common yellowthroat | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| All species combined | 106 | 11 | 6 | 32 | 38 | 2 | 17 |

[a]Four nests were eliminated because they were abandoned as a result of human disturbance, and 2 nests were eliminated because their outcome was unknown.

alfalfa crop (Section I), their nests were the most common (Table 1). Redwing nest success, however, was low (Table 2). Best and Stauffer (1980) reported somewhat higher nest success (16%) for redwings in Iowa riparian habitats. Apparent nest success (percentage of nests observed in which 1 nestling fledged) in upland habitats has generally been about 35% (e.g., Robertson 1972, Blakley 1976, Brown and Goertz 1978) but has ranged from 4 (Krapu 1978) to 46% (Ducey and Miller 1980).

Dickcissel nest success in alfalfa fields was the lowest of all species studied (Table 2). Zimmerman (1982) calculated dickcissel nest success as 14 and 15% in old-field and prairie habitats, respectively. Nest success (daily survival rate) in my alfalfa fields was significantly less than the combined nest success in these old-field and prairie habitats (0.8125 vs. 0.9294, $\underline{Z} = -3.76$, $\underline{P} < 0.005$). Nest success was recalculated from Zimmerman (1982:Table 1) to include only the period from egg-laying through brooding (4817 exposure days, 340 nests destroyed, and 24-day nest cycle).

Meadowlark nest success also was low in my study fields (Table 2). For comparison, I calculated nest success for western meadowlarks using data (660 exposure days, 42 nests destroyed, and 30-day nest cycle) from Johnson (1985) for tall-grass prairie. Nest success in my alfalfa fields was

Table 2. Nest success[a] of nongame birds in alfalfa fields during 1986-87

| Species | Nesting cycle length (days)[b] | Days of exposure | Daily survival rate | SD | Nest success (%) |
|---|---|---|---|---|---|
| Red-winged blackbird | 24 | 315 | 0.8824 | 0.0182 | 5.0 |
| Dickcissel | 24 | 160 | 0.8125 | 0.0309 | 0.6 |
| Vesper sparrow | 24 | 88 | 0.9318 | 0.0269 | 18.4 |
| Western meadowlark | 30 | 63.5 | 0.8740 | 0.0416 | 1.8 |
| Mourning dove | 28 | 78 | 0.9487 | 0.0250 | 22.9 |
| Grasshopper sparrow | 25 | 41 | 0.9268 | 0.0407 | 15.0 |

[a]Calculated for nesting cycle by using the Mayfield method (1975).

[b]Nest cycle length of red-winged blackbirds based on Besser et al. (1987); dickcissels, Zimmerman (1982); vesper sparrows, Rodenhouse and Best (1983); western meadowlarks, Roseberry and Klimstra (1970); mourning doves, Westmoreland and Best (1985); and grasshopper sparrows, Smith (1963).

not significantly different from that in the prairie (1.8% vs 14%; 0.8740 vs. 0.9376, *Z* = -1.45, *P* = 0.15). Lanyon (1957) reported that 35% of the western meadowlark nests were successful (apparent success) in unmowed grasslands. Similarly, eastern meadowlark (*Sturnella magna*) nest success (apparent) has ranged from 31 to 44% (Lanyon 1957, Roseberry and Klimstra 1970, Knapton 1988) in grasslands.

Vesper sparrow nest success in alfalfa fields, although higher than that of the previously mentioned species, was still less than 20% (Table 2). In comparison, Wray et al. (1982) reported 15 to 22% in restored grasslands, Rodenhouse and Best (1983) calculated 13% nest success (about 395 exposure days, 32 nests destroyed, and 24-day nest cycle) in corn and soybean fields, and Best (as cited by Rodenhouse 1981) reported 41% (about 275 exposure days, 10 nests destroyed, and 24-day nest cycle) in sagebrush grasslands. My nest success in alfalfa fields was not significantly different from either of the latter two estimates (0.9318 vs. 0.9190 and 0.9636, *Z* = 0.43 and -1.09, *P* = 0.67 and 0.28).

Mourning dove nest success was the highest of the species I studied (Table 2), but few nests were found. In comparison, Olson (1980) reported that nest success for mourning dove ground nests in native prairie ranged from 31 to 36%. Similarly, Rodgers (1983) reported 31% nest success for ground nesting doves in wheat-stubble fields. My nest success in alfalfa fields was not significantly different from Rodgers' estimate (0.9487 vs. 0.9588, $\underline{Z} = -0.35$, $\underline{P} = 0.73$).

Grasshopper sparrow nest success in alfalfa fields was comparable to that of the vesper sparrow. Wray et al. (1982) reported that grasshopper sparrow nest success ranged from 7 to 47% on reclaimed surface mines (grasslands) in West Virginia. I calculated 13% nest success for grasshopper sparrows using data (363 exposure days, 28 nests destroyed, and 25-day nest cycle) from Johnson (1985). Nest success in my alfalfa fields was not significantly different from this latter estimate (0.9268 vs. 0.9233, $\underline{Z} = 0.09$, $\underline{P} = 0.93$).

I found only 1 common yellowthroat nest in my alfalfa fields. This nest was destroyed during mowing before the clutch was complete (3 exposure days). In comparison, Stewart (1953) reported that common yellowthroat nest success (apparent) was 37% in Michigan wetlands, and Hofslund (1959) reported that 25 of 50 (50%) common yellowthroat nests were successful.

## Factors Affecting Nest Success

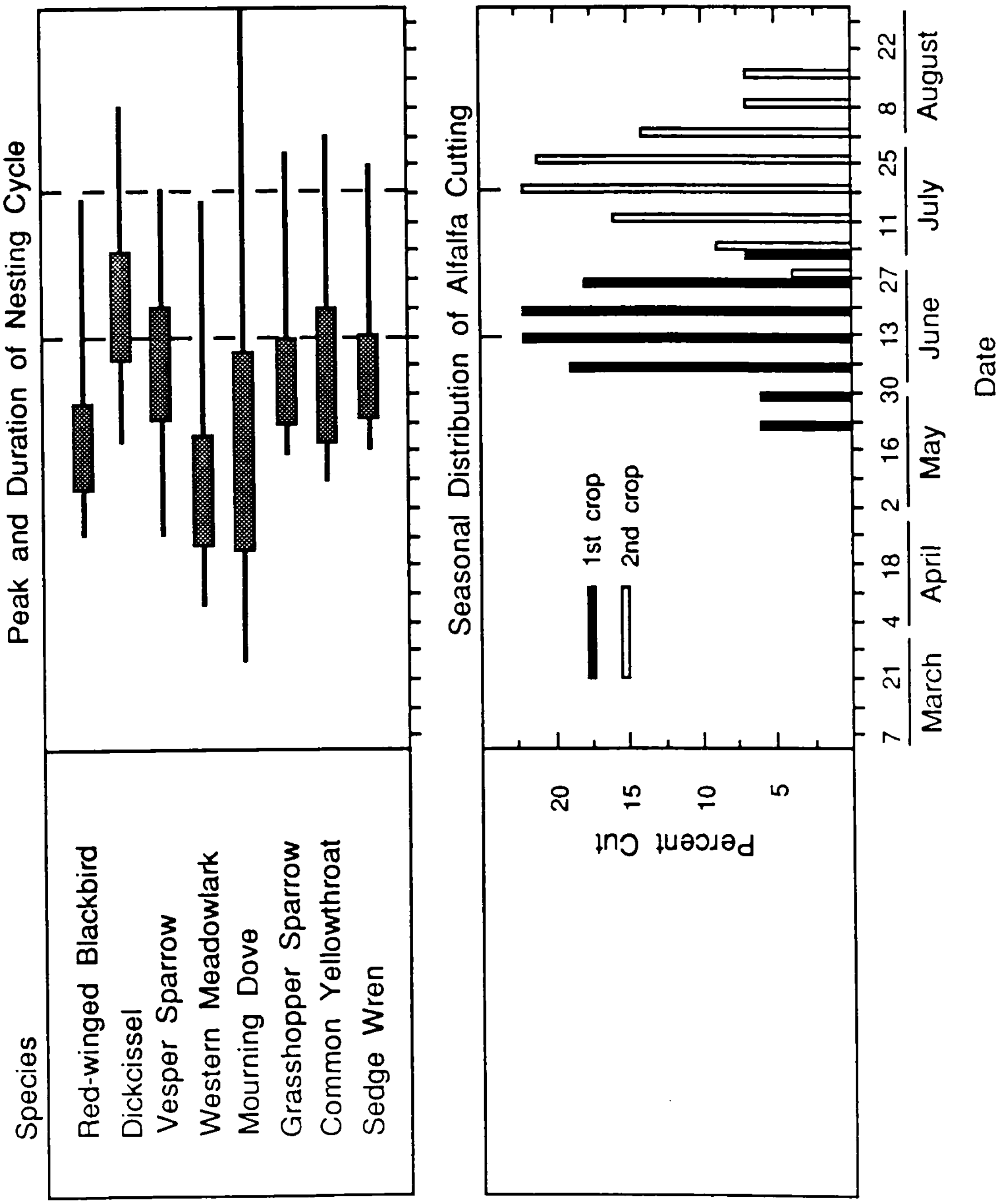
Hay mowing was the main cause of nest failures, accounting for 36% of all nest losses. Hay harvesting operations were a major cause of low nest success for the species that placed their nests in the alfalfa field vegetation (Table 1) as 100, 50, and 41% of yellowthroat, dickcissel, and redwing nests, respectively, were destroyed. Mowing typically reduces alfalfa to stubble standing 7-10 cm tall (Barnes and Sheaffer 1985). Common yellowthroats and red-winged blackbirds never nested on the ground, and only 3 of 37 (8%) dickcissel nests were on the ground; thus, it was very unlikely that their nests would escape destruction when mowing occurred. All redwing, dickcissel, and yellowthroat nests ($n$ = 18, 17, and 1; respectively) active at the time of mowing were destroyed. In contrast, fewer nests of ground-nesting species (i.e., sum of all vesper and grasshopper sparrows, western meadowlark, and mourning dove nests) were destroyed during the haying process (Table 1). Daily mortality rates due to mowing were significantly different between ground-nesting species and species nesting in the vegetation (0.0111 [ground nesters] vs. 0.0732, $Z = -4.60$, $P < 0.002$). Furthermore, only 4 of 8 (50%) nests built by ground-nesters and active (all with nestlings) at the time of mowing were destroyed during the haying process.

The timing of mowing greatly influenced nest success. Both redwings and dickcissels fledged young before mowing in 1986 when hay mowing schedules progressed normally (Iowa Crop and Livestock Rep. Serv. 1987), but both failed to fledge young in 1987 when hay was mowed earlier than normal (see also Harrison 1974). Dickcissel and red-winged blackbird nest success was greater in the first alfalfa crop in 1986 than in 1987 (dickcissel: 20.2 vs. 0%; 0.9355 vs. 0.5000, $\underline{Z} = 2.43$, $\underline{P} = 0.02$; redwing: 12.0 vs. 1.8%; 0.9154 vs. 0.8456, $\underline{Z} = 1.90$, $\underline{P} = 0.06$).

The dates when males and females arrived in the spring (i.e., the migration schedule) also influenced nest success. Late arriving species (e.g., dickcissels, sedge wrens, and yellowthroats) had less time to complete their nesting cycle before the first mowing than early arriving species (e.g., mourning doves and meadowlarks). The length of the nesting cycle generally ranges from 23-30 days for the 8 nesting species (Table 2, Walkinshaw 1935, Hofslund 1959). Assuming that mowing occurs on 12 June, the statewide average date for the first cutting (Iowa Crop and Livestock Rep. Serv. 1987), egg laying must begin before 12-19 May for the various species to successfully fledge young. When the beginning and peaks of the nesting cycles (shortest period when 50% of the nests normally are initiated) are compared to the average mowing date (Fig. 1), it is readily apparent why nest success on my alfalfa fields was so low. Rarely are nests left undisturbed for enough time to fledge young.

Western meadowlarks, mourning doves, and vesper and grasshopper sparrows generally arrived early enough to complete their nesting cycle before the first mowing (Section I). Of these species, only meadowlarks were abundant immediately before mowing (30 May), presumably

Figure 1. Seasonal distribution of alfalfa mowing (Iowa Crop Livestock Rep. Serv. 1987) and the timing of nest initiation for the bird species breeding in alfalfa fields. Peaks (shortest period within which 50% of nests were started [shaded areas]) and timing of nesting seasons were obtained from George (1952), Hofslund (1953), Downing (1957), Roseberry and Klimstra (1970), Dolbeer (1976), Monahan (1977), Burns (1982), Rodenhouse and Best (1983), and Zimmerman (1983). The vertical dashed lines represent the statewide mean first and second alfalfa crop mowing date.


Peak and Duration of Nesting Cycle
Species
Red-winged Blackbird
Dickcissel
Vesper Sparrow
Western Meadowlark
Mourning Dove
Grasshopper Sparrow
Common Yellowthroat
Sedge Wren
Seasonal Distribution of Alfalfa Cutting
1st crop
2nd crop
Percent Cut
20
15
10
5
7
21
4
18
2
16
30
13
27
11
25
8
22
March
April
May
June
July
August
Date

because attributes of the vegetation were less suitable for the other 3 species at this time (Section I). Early arrival, however, did not guarantee nest success because losses to predators were high (Table 1).

Nest success also depended upon the development of the vegetation. Upon arrival in the spring, most males immediately established territories, contingent upon the availability of suitable habitat. Territory establishment and nesting by red-winged blackbirds were likely delayed until new vegetation had grown sufficiently to provide adequate nest support and other territory requisites (late April through mid-May, Section I) (see also Holcomb and Twiest 1968, Robertson 1973, Albers 1978). Consequently, egg laying was delayed, and the nesting cycle overlapped the start of mowing.

Predation also was a major cause of nest loss (Table 1). Although ground-nesting species had more of their nests destroyed by predators than species nesting in the vegetation (47 vs 24%), daily mortality rates due to predation were not significantly different (0.0518 [ground nesters] vs. 0.0377, $Z = 0.89$, $P = 0.38$). Other researchers have reported no difference between nest height and nest success that was influenced largely by predation (e.g., Francis 1973, Harmeson 1974, Krapu 1978).

The cowbird parasitism also contributed to the low nest success. Fifty-six percent (18 of 32) and 41% (12 of 29) of all nests (except those belonging to mourning doves) with a complete clutch in the first and second crops, respectively, had cowbirds eggs present. Mourning dove nests were eliminated because cowbirds rarely parasitize their nests (Hill 1976). Parasitism did not differ between the first and second crops ($\underline{X}^2 = 0.81$, 1 df, $\underline{P} > 0.10$). High parasitism rates are typical of prairie communities (e.g., Wiens 1963, Zimmerman 1983, Lowther 1984). Dickcissel and red-winged blackbird nests had the highest levels of parasitism of all species nesting in alfalfa fields and were abandoned the most often as a result of parasitism (Table 1). Cowbird eggs were present in 12 of 18 (67%) dickcissel and 12 of 24 (50%) redwing nests with a complete clutch. Regionally, the frequency of cowbird parasitism of both dickcissels and redwings is positively correlated with cowbird densities (Fleischer 1986). In the central plains states, dickcissels commonly experience high rates of cowbird parasitism (e.g., 95%, Elliott 1978; 66%, Zimmerman 1983; 65%, Fleischer 1986). Similarly, redwings commonly experience parasitism of 20 to 55% of their nests (e.g., Hill 1976, Fleischer 1986, Blankespoor et al. 1982). In addition, upland nesting redwings (viz., in areas with low redwing population density) generally experience higher rates of parasitism than redwings nesting in wetlands (Friedman 1963, Linz and Bolin 1982).

Nesting attempts in the second alfalfa crop also usually were unproductive. The average time between the first and second alfalfa cuttings on my study fields was 39 days. Recolonization by dickcissels did not begin until about 2 weeks after the first mowing and then progressed slowly (Section I). The average date of nest initiation was 30 $\pm$ 8 days ($\underline{n}$ = 6) after mowing. Again, dickcissels did not have enough time to complete their nesting cycle; most nests (13 of 21) constructed in the second alfalfa crop were destroyed during mowing. Dickcissel nest success (0%) in the second alfalfa crop was significantly lower than that of grasshopper sparrows (17.8%) and vesper sparrows (30.1%) (0.7219 vs. 0.9333 and 0.9512; $\underline{Z}$ = -3.07 and -4.04, respectively, $\underline{P}$ < 0.05).

Western meadowlarks, and vesper and grasshopper sparrows had the best chance of successfully completing their nesting cycle in the second alfalfa crop because their population densities in the alfalfa fields either were unaffected or increased soon after the first mowing (Section I). Thus, these species potentially could make maximum use of the time between cuttings. The average date when these species nests were initiated (first egg laid) after the first mowing was 14 $\pm$ 5 days ($\underline{n}$ = 13), and no nests were initiated later than 28 days ($\underline{n}$ = 19) after the first mowing. Western meadowlarks, and vesper and grasshopper sparrows need 24 to 30 days to complete their nest cycle (Table 2); thus, allowing for 14 days between mowing and nest initiation, 38 to 44 days are required between the first and second mowings to enable nesting cycles to be completed. Because the period between the first and second mowing averaged 39 days, these species will usually be subjected to hay harvesting induced nest failures. Furthermore, any factor(s) that either delayed the beginning of the nesting cycle (e.g., delayed territorial establishment, delayed vegetation growth, inclement weather) or shortened the mowing interval (e.g. farmer's schedule) would seriously jeopardize their potential for nest success.

## Productivity

Estimated annual productivity (fledglings/territory) generally was low for all species: 0.35 for red-winged blackbirds, 0.17 for dickcissels, 0.06 for western meadowlarks, 2.40 for vesper sparrows, 1.60 for mourning doves, and 0.62 for grasshopper sparrows. Productivity should average between 3.3 and 6.7 fledglings annually to sustain bird populations suffering 50% adult mortality (Lack 1968) and between 70 and 85% fledgling mortality (Ricklefs and Bloom 1977, Pinowski 1979, Baker et al. 1981). Consequently, birds nesting in alfalfa fields are reproducing below replacement levels. Wiens and Rotenberry (1981) and Pulliam (1988) refer to such populations as "sink" populations that depend on emigrants from regional and other local populations ("source" populations) to sustain their numbers. Other researchers also have suggested that "source" and "sink" populations exist for vesper (Wray et al. 1982, Rodenhouse and Best 1983) and grasshopper sparrows (Wray et al. 1982).

Birds species commonly found in hayfields have persisted despite low productivity, but populations of these species have declined recently (e.g., meadowlarks, dickcissels, and grasshopper sparrows). Although "source" populations do exist for the dickcissels, western meadowlarks, and grasshopper sparrows, they appear less able to sustain regional populations now than in the past.

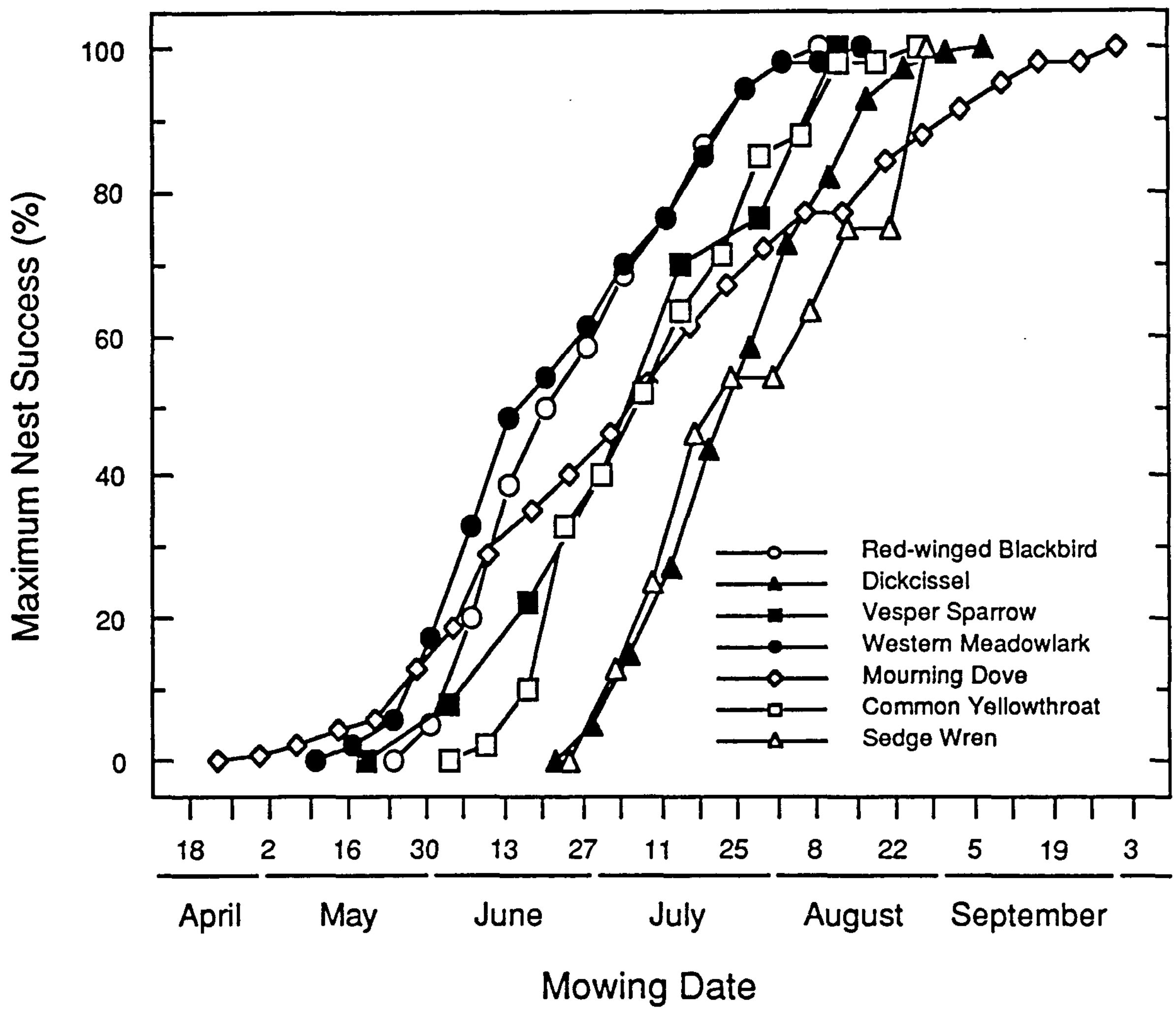
## Management Implications

Alfalfa fields act as "ecological traps" in a manner similar to that described by Gates and Gysel (1978), Best (1986), and Bollinger (1988). Alfalfa fields attract nesting birds because they provide sites suitable for nesting and possibly because some birds exhibit site tenacity (George 1952, Bollinger and Gavin 1989). But because of the practice of mowing and other mortality factors (Table 1), most nesting attempts fail.

The extent to which fields act as population sinks depends largely on the mowing schedule and the birds' nesting phenology (see also Labisky 1957, Milonski 1958, Gates 1965, Gates and Hale 1975, Hartman and Fisher 1984). To evaluate these effects, I calculated maximum nest success for the species nesting in my fields when the alfalfa is mowed at various dates throughout the nesting season (Fig. 2). Maximum nest success was determined by calculating the number of nests which could have fledged young before mowing on the basis of the seasonal distribution of nests initiated in unmowed habitats. Calculations of maximum nest success assume that all nests active at the time of mowing are destroyed and that subsequent nests in the second crop also are destroyed. In addition, no other mortality factors are operating; thus, the projections (Fig. 2) represent the maximum gain in nest survival that could be achieved by delaying mowing.

The greater the overlap between the nesting and mowing cycles, the greater the negative effect of mowing on reproduction (Fig. 2). For example, if mowing occurred at about mid-June, red-winged blackbirds would be prevented from completing nearly 60% of the nests expected in an unmowed field because the birds in a mowed field would not return to these fields to nest (Harrison 1974, Albers 1978, Section I). If mowing occurred during early June, however, over 90% of the nests would be either destroyed or prevented from being constructed. Likewise, dickcissels would be prevented from completing nearly 60% of the nests expected in an uncut field if mowing occurred at about mid-July because

Figure 2. Predicted maximum nest survival when mowing occurs during the breeding season. The timing of nesting seasons was obtained from Hofslund (1953), Downing (1957), Roseberry and Klimstra (1970), Dolbeer (1976), Monahan (1977), Burns (1982), Rodenhouse and Best (1983), and Zimmerman (1983).



Maximum Nest Success (%)
100
80
60
40
20
0
Red-winged Blackbird
Dickcissel
Vesper Sparrow
Western Meadowlark
Mourning Dove
Common Yellowthroat
Sedge Wren
18
2
16
30
13
27
11
25
8
22
5
19
3
April
May
June
July
August
September
Mowing Date

the birds in a mowed field would not have sufficient time to rear young between the first and second mowings. Sedge wrens and common yellowthroats are also late nesters (Fig. 2) and would likely be prevented from completing most nesting attempts by early mowing (i.e., before mid-July).

The relationship between mowing and nest success for ground-nesting species was less clear than that for species nesting in the vegetation because a smaller proportion of all ground nests were destroyed by mowing (Table 1). Also, not all ground nests active at time of mowing were destroyed, and sometimes enough time was available between the first and second mowings for these species to nest successfully. Yet mowing is an important factor influencing nest success because 4 of 8 nests belonging to ground nesters and active at the time of hay harvesting were destroyed. In comparison, Bollinger (1988) reported that 94% of the eggs and nestlings found in nests active at the time of hay harvested were destroyed. My estimate of nest survival seemingly is greater than that of Bollinger because all my ground nests contained nestlings ($\bar{x}$ nestling age = 7 $\pm$ 4.5 days) at the time of mowing. Bollinger reported that nests active at the time of hay harvesting and containing nestlings are less likely to be abandoned than nests with eggs. My maximum nest survival predictions (Fig. 2) are probably underestimated for ground nesting species because these predictions do not allow for any survival; whereas, I observed 50% nest survival.

Alfalfa acreage in the U.S. has nearly doubled since the 1950's (Barnes and Sheaffer 1985). In addition, producers have placed greater importance on forage quality rather than quantity when selecting mowing dates and cultivars. Consequently, hay mowing has occurred progressively earlier in the spring (Warner and Etter 1989). Modern alfalfa varieties can be cut 4 times annually in Iowa and still maintain good yields (Wedin 1983). My results indicate that bird productivity in alfalfa fields can be greatly reduced and, in many instances, completely eliminated by early mowing.

Ultimately, the suitability of alfalfa fields for breeding birds is influenced by the occurrence of mowing. Ring-necked pheasant nest success improved greatly in hayfields when mowing was delayed (Hartman and Fisher 1984). Delayed mowing probably would greatly improve reproduction of the other bird species nesting in alfalfa fields. The timing of alfalfa harvest, however, largely depends upon management objectives. Highest yields are obtained by harvesting alfalfa when it reaches late stages of development, but the highest quality forage is obtained by harvesting during early stages of development (Barnes and Sheaffer 1985). Most forage managers compromise between harvesting for maximum quality and quantity by attempting to harvest the crop when it achieves the greatest amount of digestible nutrients per unit area. In Iowa, this generally results in harvesting the alfalfa first during early June when it begins flowering and then 2 more times at about 5 1/2-week intervals (Iowa Crop Rep. Serv. 1987). Few farmers could be expected to accept the potential economic losses (lower yields and quality forage) resulting from delaying their mowing schedule to benefit the birds nesting in alfalfa fields. Historically, farmers have been reluctant to sacrifice potential profits for the good of the overall farm economy or to protect wildlife (Leitch and Nelson 1985, Nicholson 1985). These circumstances are unlikely to change as long as farmers have little or no incentive to conserve wildlife.

Clearly, mowing reduces productivity of birds attempting to nest in alfalfa fields (Table 1). Thus, it is vital to maintain grasslands that will remain undisturbed throughout the nesting season for breeding birds to maintain "source" areas. Land enrolled in federal land retirement programs, such as the Food Security Act of 1985, may provide "source" areas. It is important, however, that farmers who participate in these programs do not mow their enrolled land during the breeding season.

## LITERATURE CITED

Adams, R. J., Jr., G. A. McPeek, and D. C. Evers. 1988. Bird population changes in Michigan, 1966-1985. Jack-Pine Warbler 66:71-86.

Anonymous. 1983. The declining grassland birds. Illinois Nat. Hist. Surv. Rep. 227.

Albers, P. H. 1978. Habitat selection by breeding red-winged blackbirds. Wilson Bull. 90:619-634.

Applegate, R. D., and A. G. Willms. 1987. Distribution and population trend of western meadowlarks in Illinois. Prairie Nat. 19:145-148.

Baker, M. C., L. R. Mewaldt, and R. M. Stewart. 1981. Demography of white-crowned sparrows (*Zonotrichia leucophrys nuttalli*). Ecology 62:636-644.

Barnes, D. K., and C. C. Sheaffer. 1985. Alfalfa. Pages 89-97 *in* M. E. Heath, R. F. Barnes, and D. S. Metcalfe, eds. Forages: The science of grassland agriculture. Fourth ed. Iowa State Univ. Press, Ames.

Besser, J. F., O. E. Bray, J. W. De Grazio, J. L. Guarino, D. L. Gilbert, R. R. Martinka, and D. A. Dysart. 1987. Productivity of red-winged blackbirds in South Dakota. Prairie Nat. 19:221-232.

Best, L. B., and D. F. Stauffer. 1980. Factors affecting nesting success in riparian bird communities. Condor 82:149-158.

Best, L. B. 1986. Conservation tillage: Ecological traps for nesting birds? Wildl. Soc. Bull. 14:308-317.

Blakley, N. R. 1976. Successive polygyny in upland nesting redwinged blackbirds. Condor 78:129-133.

Blankespoor, G. W., J. Oolman, and C. Uthe. 1982. Eggshell strength and cowbird parasitism of red-winged blackbirds. Auk 99:363-365.

Bollinger, E. K. 1988. Breeding dispersion and reproductive success of bobolinks in an agricultural landscape. Ph.D. Thesis. Cornell Univ., Ithaca, N.Y. 189 pp.

Bollinger, E. K., and T. A. Gavin. 1989. The effects of site quality on breeding-site fidelity in bobolinks. Auk 106:584-594.

Brown, B. T., and J. W. Goertz. 1978. Reproduction and nest site selection by red-winged blackbirds in north Louisiana. Wilson Bull. 90:261-270.

Burns, J. T. 1982. Nests, territories, and reproduction of sedge wrens (Cistothorus platensis). Wilson Bull. 94:338-349.

Case, N. A., and O. H. Hewitt. 1963. Nesting and productivity of the red-winged blackbird in relation to habitat. Living Bird 2:7-20.

Castrale, J. S. 1985. The Breeding Bird Survey in Indiana: Eighteen years of overlooked data. Ind. Audubon Q. 63:15-30.

Dolbeer, R. A. 1976. Reproductive rate and temporal spacing of nesting red-winged blackbirds in upland habitat. Auk 93:343-355.

Downing, R. L. 1957. An evaluation of ground nesting by mourning doves in northwestern Oklahoma. M.S. Thesis. Okla. State Univ., Stillwater. 35 pp.

Ducey, J., and L. Miller. 1980. Birds of an agricultural community. Nebr. Bird Rev. 48:58-68.

Elliott, P. 1978. Cowbird parasitism in the Kansas tallgrass prairie. Auk 95:161-167.

Fleischer, R. C. 1986. Brood parasitism by brown-headed cowbirds in a simple host community in eastern Kansas. Kans. Ornithol. Soc. Bull. 37:21-29.

Francis, W. J. 1973. Blackbird nest placement and nesting success. Wilson Bull. 85:86-87.

Friedman, H. 1963. Host relations of the parasitic cowbirds. U.S. Natl. Mus. Bull. 223. 196 pp.

Gates, J. M. 1965. Duck nesting and production on Wisconsin farmlands. J. Wildl. Manage. 29:515-523.

Gates, J. M., and J. B. Hale. 1975. Reproduction of an east central Wisconsin pheasant population. Wisc. Dep. Nat. Resour. Tech. Bull. 85. 70 pp.

Gates, J. E., and L. W. Gysel. 1978. Avian nest dispersion and fledgling success in field-forest ecotones. Ecology 59:871-883.

George, J. L. 1952. The birds on a southern Michigan farm. Ph.D. Thesis. Univ. Mich., Ann Arbor. 413 pp.

Goddard, S. W., and V. V. Board. 1967. Reproductive success of red-winged blackbirds in north central Oklahoma. Wilson Bull. 79:283-289.

Harmeson, J. P. 1974. Breeding ecology of the dickcissel. Auk 91:348-359.

Harrison, K. G. 1974. Aspects of habitat selection in grassland birds. M.A. Thesis. West. Mich. Univ., Kalamazoo. 82 pp.

Hartman, F. E., and R. Fisher. 1984. Pheasant nesting success with delayed hay mowing in Pennsylvania: Preliminary results. Pages 110-116 in R. T. Dumke, R. B. Stiehl, and R. B. Kahl, eds. Perdix III: Gray partridge and ring-necked pheasant workshop. Wisc. Dep. Nat. Resour., Madison.

Heisey, D. M., and T. K. Fuller. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. J. Wildl. Manage. 49:668-674.

Hill, R. A. 1976. Host-parasite relationships of the brown-headed cowbird in a prairie habitat of west-central Kansas. Wilson Bull. 88:555-565.

Hofslund, P. B. 1953. A life history study of the yellow-throat, Geothlypis trichas. Ph.D. Thesis. Univ. Mich., Ann Arbor. 172 pp.

Hofslund, P. B. 1959. A life history study of the yellowthroat, Geothlypis trichas. Proc. Minn. Acad. Sci. 27:144-174.

Holcomb, L. C., and G. Twiest. 1968. Ecological factors affecting nest building in red-winged blackbirds. Bird-Banding 42:1-17.

Iowa Crop and Livestock Reporting Service. 1985. Iowa Agricultural Statistics. Iowa Dep. Agric., Des Moines and U.S. Dep. Agric. Stat. Rep. Serv., Washington, D.C. 177 pp.

Iowa Crop and Livestock Reporting Service. 1987. Iowa crops and weather. Iowa Dep. Agric., Des Moines and U.S. Dep. Agric. Stat. Rep. Serv., Washington, D.C., May-August Issues.

Iowa Crop and Livestock Reporting Service. 1989. Iowa crop report. Iowa Dep. Agric., Des Moines and U.S. Dep. Agric. Stat. Rep. Serv., Washington, D.C. 89(1).

Johnson, R. G. 1985. Effects of prairie management practices on nesting birds. M.S. Thesis. Univ. Wisc., Madison. 53 pp.

Klett, A. T., and D. H. Johnson. 1982. Variability in nest survival rates and implications to nesting studies. Auk 99:77-87.

Knapton, R. W. 1988. Nesting success is higher for polygynously mated females than for monogamously mated females in the eastern meadowlark. Auk 105:325-329.

Krapu, G. L. 1978. Productivity of red-winged blackbirds in prairie pothole habitat. Iowa Bird Life 48:24-30.

Labisky, R. F. 1957. Relation of hay harvesting to duck nesting under a refuge-permittee system. J. Wildl. Manage. 21:194-200.

Lack, D. 1968. Ecological adaptations for breeding in birds. Methuren Publ. Co., Ltd., London. 409 pp.

Lanyon, W. E. 1957. The comparative biology of the meadowlarks (Sturnella) in Wisconsin. Publ. Nuttall Ornithol. Club 1:1-67.

Leitch, J. A., and W. C. Nelson. 1985. Economics of joint production of agricultural commodities and wildlife. Pages 121-128 in Technologies to benefit agriculture and wildlife-workshop proceedings. Office of Technology Assessment, Washington, D.C.

Linz, G. M., and S. B. Bolin. 1982. Incidence of brown-headed cowbird parasitism on red-winged blackbirds. Wilson Bull. 94:93-95.

Lowther, P. E. 1984. Chickadee, thrasher, and other cowbird hosts from northwest Iowa. J. Field Ornithol. 54:414-418.

Mayfield, H. F. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456-466.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. Trans. N. Am. Wildl. Conf. 23:215-227.

Monahan, M. W. 1977. Determinants of male pairing success in the red-winged blackbird (Agelaius phoeniceus): A multivariate, experimental analysis. Ph.D. Thesis. Ind. Univ., Bloomington. 169 pp.

National Oceanic and Atmospheric Administration. 1987. Local climatological data, annual summaries for 1987, part III - Central region. Natl. Climatic Center, Asheville, N.C.

Nicholson, A. G. 1985. The development of agriculture in New York State. Cornell Univ. Nat. Resour. Res. and Ext. Ser. 23. 41 pp.

Olson, T. E. 1980. Mourning doves and land use changes in eastern Colorado. M.S. Thesis. Colo. State Univ., Fort Collins. 119 pp.

Pinowski, B. C. 1979. Annual productivity and its measurement in a multibrooded passerine, the eastern bluebird. Auk 96:562-572.

Pulliam, H. R. 1988. Sources, sinks, and population regulation. Am. Nat. 132:652-661.

Ricklefs, R. E., and G. Bloom. 1977. Components of avian breeding productivity. Auk 94:86-96.

Robbins, C. S., D, Bystrak, and P. H. Geissler. 1986. The Breeding Bird Survey: Its first fifteen years, 1965-1979. U.S. Fish Wildl. Serv. Resour. Publ. 157. 196 pp.

Robbins, S. 1982. Wisconsin's Breeding Bird Survey results: 1966-1980. Passenger Pigeon 44:97-119.

Robertson, R. J. 1972. Optimal niche space of the red-winged blackbird (Agelaius phoeniceus). I. Nesting success in marsh and upland habitat. Can. J. Zool. 50:247-263.

Robertson, R. J. 1973. Optimal niche space of the red-winged blackbird: Spatial and temporal patterns of nesting activity and success. Ecology 54:1085-1093.

Rodenhouse, N. L. 1981. Breeding ecology of vesper sparrow in corn and soybean fields. M.S. Thesis. Iowa State Univ., Ames. 69 pp.

Rodenhouse, N. L., and L. B. Best. 1983. Breeding ecology of vesper sparrow in corn and soybean fields. Am. Midl. Nat. 110:265-275.

Rodgers, R. D. 1983. Reducing wildlife losses to tillage in fallow wheat fields. Wildl. Soc. Bull. 11:31-38.

Roseberry, J. L., and W. D. Klimstra. 1970. The nesting ecology and reproductive performance of the eastern meadowlark. Wilson Bull. 82:243-267.

Ryan, M. R. 1986. Nongame management in grassland and agricultural ecosystems. Pages 117-136 in J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the Midwest: A developing art. Book Crafters, Chelsea, Mich.

Sealy, S. G. 1976. The 1973 dickcissel invasion of southern Manitoba. Can. Field-Nat. 90:464-466.

Sherwood, M. A. 1980. Soil survey of Adair County, Iowa. U.S. Dep. Agric., Soil Conserv. Serv., Washington, D.C. 146 pp.

Smith, R. L. 1963. Some ecological notes on the grasshopper sparrow. Wilson Bull. 75:159-165.

Stewart, R. E. 1953. A life history study of the yellow-throat. Wilson Bull. 65:99-115.

Tabor, R. D. 1947. The dickcissel in Wisconsin. Passenger Pigeon 10:39-46.

Thompson, C. F., and B. M. Gottfried. 1976. How do cowbirds find and select nests to parasitize? Wilson Bull. 88:673-675.

Walkinshaw, L. H. 1935. Studies of short-billed marsh wren (Cistothorus stellaris) in Michigan. Auk 52:362-370.

Warner, R. E., and S. L. Etter. 1989. Hay cutting and the survival of pheasants: A long-term perspective. J. Wildl. Manage. 52:455-461.

Wedin, W. F. 1983. Crop rotation designs. Pages 27-31 in R. B. Dahlgren, ed. Proceedings of the management alternatives for biological farming workshop. Iowa Coop.

Fish and Wildl. Res. Unit, Iowa State Univ., Ames.

Westmoreland, D., and L. B. Best. 1985. Effects of researcher disturbance on mourning dove nesting success. Auk 102:774-780.

Wiens, J. A. 1963. Aspects of cowbird parasitism in southern Oklahoma. Wilson Bull. 75:130-139.

Wiens, J. A., and J. T. Rotenberry. 1981. Censusing and the evaluation of avian habitat occupancy. Stud. Avian Biol. 6:522-532.

Wray, T., II, K. A. Strait, and R. C. Whitmore. 1982. Reproductive success of grassland sparrows on a reclaimed surface mine in West Virginia. Auk 99:157-164.

Zaletel, L. R., and J. J. Dinsmore. 1985. Breeding bird populations in Iowa, 1968-1980. Proc. Iowa Acad. Sci. 92:85-94.

Zimmerman, J. L. 1979. Ten year summary of the Kansas breeding-bird survey: Trends. Kans. Ornithol. Soc. Bull. 30:17-19.

Zimmerman, J. L. 1982. Nesting success of dickcissels (*Spiza americana*) in preferred and less preferred habitats. Auk 99:292-298.

Zimmerman, J. L. 1983. Cowbird parasitism in dickcissels in different habitats and at different densities. Wilson Bull. 95:7-22.

## SUMMARY

Eight nongame bird species established territories in alfalfa (*Medicago sativa*) fields before mowing occurred. In order of decreasing abundance on 30 May they were dickcissels (*Spiza americana*), red-winged blackbirds (*Agelaius phoeniceus*), western meadowlarks (*Sturnella neglecta*), common yellowthroats (*Geothlypis trichas*), sedge wrens (*Cistothorus platensis*), grasshopper sparrows (*Ammodramus savannarum*), mourning doves (*Zenaida macroura*), and vesper sparrows (*Pooecetes gramineus*). The occurrences of common yellowthroats and grasshopper sparrows within alfalfa fields was related to the distribution of suitable vegetation. Common yellowthroats selected the tallest, densest vegetation with a relatively high coverage of grass; grasshopper sparrows used areas of sparse vegetation. In contrast, dickcissels and red-winged blackbirds were distributed throughout the alfalfa fields, although their abundance was directly related to vegetation density throughout the period of alfalfa regrowth. Vesper sparrow and grasshopper sparrow abundance seemed to be directly related to vegetation density (structure) until the alfalfa reached a height of about 30 cm; at greater alfalfa heights, the abundance of these species seemed inversely related to vegetation density. Western meadowlark abundance seemed unrelated to vegetation changes.

Mowing reduced the density and the number of nongame species attempting to nest in alfalfa fields. Only dickcissels, grasshopper sparrows, western meadowlarks, and vesper sparrows bred in the second alfalfa crop. Hay harvesting operations were the main cause of nest failures, accounting for 36% of all nest losses. Mowing had the greatest effect on dickcissels and red-winged blackbirds; 50 and 41% of their nests, respectively, were destroyed by mowing operations. Bird productivity in alfalfa fields was estimated to be below levels needed to compensate for nest failures. Thus, alfalfa fields act like ecological traps in that birds are attracted to the fields, but most nest attempts are unsuccessful. Factors that either hasten the mowing schedule or delay nesting are especially detrimental to nest success. Bird productivity probably could be improved by delayed mowing; however, the management objectives of private landowners generally prevent delayed mowing.

Utilitarian motives have directed the development of our agricultural system, to the general disadvantage of most native plants and animals (Leopold 1939, 1945). In Iowa, less than 0.02% of presettlement prairie remains (Smith 1981). Thus, grassland birds have of necessity, had to nest in hayfields and other similar habitats to survive (Dinsmore 1981).

Leopold (1939) defined conservation as harmony between men and land. He felt that when both the land and its owner ended up better because of their partnership, we had conservation. Conservation seeks to balance utility and beauty of the land; it is a challenge to use the earth without making it ugly. But harmony between men and land, like harmony between neighbors, is an ideal, and one we shall never attain (Leopold as cited by Meine 1987). Yet any man who respects himself and his land can try to achieve conservation.

The landscape of any farm is the farmer's portrait of himself (Leopold 1939). Conservation implies self-expression in that landscape, rather than blind compliance with economic dogma. Thus, the challenge that faces the modern farmer, viz., hay producers, is striking the balance between production of crops and wildlife.

## ADDITIONAL LITERATURE CITED

Dinsmore, J. J. 1981. Iowa's avifauna: Changes in the past and prospects for the future. Proc. Iowa Acad. Sci. 88:28-37.

Leopold, A. 1939. The farmer as a conservationist. Am. Forests 45:294-299, 316, 332.

Leopold, A. 1945. The outlook for farm wildlife. Trans. N. Am. Wildl. Conf. 10:164-168.

Meine, C. 1987. The farmer as conservationist: Aldo Leopold on agriculture. J. Soil and Water Conserv. 412:144-149.

Smith, D. D. 1981. Iowa prairie-an endangered ecosystem. Proc. Iowa Acad. Sci. 88:7-10.

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